DOCUMENT RESUME

ED 060 928 PS 005 159

AUTHOR	Asher, J. William; And Others
TITLE	The Development of New Measures of Cognitive Variables in Elementary School Children (Phase I). Final Report.
SPONS AGENCY	Bureau of Elementary and Secondary Education (DHEW/OE), Washington, D.C.
CONTRACT	OEC-0-70-4952
NOTE	268p.
EDRS PRICE	MF-$0.65 HC-$9.87
DESCRIPTORS	Academic Achievement; Annotated Bibliographies; *Child Development; *Cognitive Processes; Comparative Analysis; *Concept Formation; Early Childhood; Elementary School Students; Environmental Influences; Literature Reviews; *Measurement Instruments; Preschool Children; Problem Solving; Research; Testing; Theories; *Thought Processes
IDENTIFIERS	*Piaget (Jean)

ABSTRACT

Many theorists have proposed formulations to explain the development of concepts in children. One of the most seminal theories for explaining concept development as it pertains to school achievement has come from the work of Piaget. Piaget posits three stages of development. The sensorimotor stage exists from birth to about two years. In this stage, the child is tied to his environment and is forming schemas to cope with his world. In the concrete operational stage, which can be broken into two phases, ages 2-7 and 7-11, the child begins to develop a semiotic function. It is the time of the emergence of the conservations. This stage is called the concrete operational because the child is still tied to reasoning from direct sensory impressions. The final stage is called the stage of propositional thought. In this stage, the child learns to analyze a problem by listing all logical possibilities and testing them systematically. The theories of Piaget and others are analyzed and compared throughout this document. Research literature on which this report is based is presented under the following headings: Review of the Literature on Cognitive Functioning in Elementary School Children; Annotated Bibliography on Cognitive Functioning in Elementary School Children; and Related Measures (review, annotated bibliography, and bibliography on Achievement Testing). (CK)

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ED 060928

Final Report
of Phase I

Contract No. OEC-0-70-4952

The Development of New Measures of Cognitive Variables in Elementary School Children (Phase I)

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PS 005159

Acknowledgement

In addition to the principal investigators listed on the cover sheet of this document a number of others have given us invaluable consultive help or have worked diligently at the task of identifying, evaluating and summarizing the research literature on which this Report is based. We wish to publicly acknowledge their contributions to this project. It may be said truly that without their input this Report would not exist.

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CONTENTS

Acknowledgement-- i

Table of Contents--ii

Introduction--- 1

Review of the Literature on Cognitive
Functioning in Elementary School Children--------------------------- 2

Concept Formation--- 3
Language Development--23
Logical Thinking--28
Problem Solving---43
Response Style--80

Annotated Bibliography on Cognitive
Functioning in Elementary School Children--------------------------A1

Concept Formation---A2
Language Development--A18
Logical Thinking--A24
Problem Solving---A41
Response Style--A64
A-Locus of Control--A64
B-Impulsivity-Reflectivity----------------------------------A70

Bibliography on Cognitive Functioning in
Elementary School Children---B1

Concept Formation---B2
Supplementary Bibliography----------------------------------B16a
Language Development--B17
Logical Thinking--B31
Problem Solving---B42
Supplementary Bibliography----------------------------------B60a
Response Style--B61
A-Locus of Control--B61
B-Impulsivity-Reflectivity----------------------------------B73

Related Measures---R1

Review of the Literature on Achievement Testing-------------R2
Annotated Bibliography on Achievement Testing---------------R5
Bibliography on Achievement Testing-------------------------R19

Concept Formation
Literature Review

Many theorists have proposed formulations to explain the development of concepts in children. Osgood (1953) developed a mediational hypothesis to account for concept growth within a neobehavioristic framework. His theory has been questioned by the Kendlers (H. Kendler, 1964; H. Kendler & T. Kendler, 1962) who suggest that young children learn through associative techniques, while the mediational responses are more appropriate for older subjects. This hypothesis has, in turn, been criticised by Anerson and Ausubel (1965). Another theory has been proposed by Goss (1961) who combined neobehavioristic and cognitive theories into a general model of concept formation which involves two stages of relationships between stimuli and terminating responses. Similarly, scholars such as Bruner (1966), Guilford (1967), Ausubel (1958), and Gesell (1949) have developed theories of cognitive growth. Guilford used a factor analytic approach to the study of concept formation in conjunction with his model of the structure of the intellect. He categorizes types of thinking as convergent (searching for a correct answer), divergent (searching for a novel response), and evaluation (determining goodness, correctness, etc.). A similar model has been proposed by Merrifield (1966), who has shown the relationship between factor analytic studies of intellect and types of learning suggested by Gagne (1965). Another use of factor analysis is suggested by the work of Osgood and others (1950) on the semantic differential, a rating scale composed of bipolar traits used to measure the connotative meanings of concepts. Three factors, evaluative, potency, and activity were identified. However, one of the most seminal theories for explaining concept development as it pertains to school achievement has come from the work of Piaget (1969).

Stages of Development

Bruner's analysis of conceptual thought into three types,inactive, iconic,and symbolic,is a very useful model for studying children's mental processes. In this analysis, Bruner creates these categories to explain the changes in a child's "image of the world." At first the child can think only with the actual object in mind. In thinking about his environment, the child first is incapable of using graphical or figurative representation but is object bound. Later the child learns to use representations, pictures, graphs, and diagrams in conceptualization. Finally he is capable of using symbolic representation which is an adult mode of thought.

There are elements of Piaget's Stage description of childhood thought development which correspond rather well to that of Bruner's.

Piaget (1969) posits three stages of development which can be related to Bruner's. The sens remotor stage exists from birth to about two years. In this stage the child is tied to his environment and is forming schemas to cope with his world. As the name implies this stage is one of physical movement coordination and rudimentary insight about objects encountered. A significant accomplishment of the child in this stage is the establishment of permanence of object. An object is no longer "gone" when it is out of the visual field.

In the concrete operational stage, which can be broken into two phases, ages 2-7 and 7-11, the child begins to develop a semiotic function. This corresponds to the ikonic level of Bruner. Piaget sees this stage as a period of transition from action to thought. It is the time of the emergence of the conservations. It is a period of shifting from a egocentric view of the world to one which uses a frame of reference which includes the individual as part of his environment, This stage is called the concrete operational because the child is still tied to reasoning from direct sensory impressions; he is incapable of propositional thought in general. This must wait until around 11 years when the average child moves to the final stage of formal operations. In this final stage the child learns to analyze a problem by listing all logical possibilities and testing them systematically. He is able to deal effectively with compound statements, drawing inferences and establishing true values by the laws of logic. He is able to construct complex arguments and reason clearly.

While Piaget's theory of cognitive development has been substantiated, particularily in the stage of concrete operations, there are definite problems with Piaget's use of logical terms in describing psychological processes. He makes extensive use of the sentential calculus, group and lattice theory. His use of logical terms is inconsistent, poorly defined and ambiguous. For example, his use of the term function is poorly defined and used in different ways, none of which agree with the mathematical use of the term. Parsons (1960, p. 75) states, "Although Piaget uses the standard notation of the propositional calculus, it turns out that he vaciliates somewhat in his interpretation of the notation, and his use of it obscures some of the features of inferences logicians call logical." It has been observed that Piaget is hard to read. This is precisely because he has a tendency to use familiar words in a special way without defining them. Furthermore he often uses a word in several different ways.

The classical view of concept formation and Piagets theory

Concept formation has been used to denote several ideas. Classically concept formation has been used to mean a common response to different stimuli. This use is concerned with differences between things: Whether an instance is positive or negative in regard to a classification. Piaget centers his attention on differences within things as Elkind (1969, p. 172-3) describes it "a young tree and a child both grow, a block of ice melts, a house gets painted, and a car gets dented." These are changes within things and this is Piaget's focus when he describes the conservations. A child does not have the concept of number until he knows that the number of a set is invariant under a transformation. It is the performance over change that is paramount. A person must learn to ignore many attributes of an object in conceiving it. In thinking of number, a child must ignore the length of a row of objects or the color or size of the objects in learning the concept of number. Thus Piaget's formulation of a theory of conservation acquisition is in effect concept formation. The concern is with recognizing that one thing remains invariant under some transformation. The concept of conservation has been learned when the child exhibits this conceptual knowledge. "The Piagetian version of the essence of a concept does not therefore contradict the discriminative response version, it complements that version." Elkind (1969, p. 176).

As a child views a conservation task he must ignore perceptually misleading attributes and respond congitively. He must reject those very apparent, "noisy", singularly non-defining attributes which lead to "perceptual seduction" in favor of a much less obvious conceptual attribute which is arrived at only through much more effort on his part. Bruner (1966, p. 192). Thus, he is forced to distringuish between what Elkind calls the apparent and the real. This is a major aspect of concept formation in the Piagetian sense.

Yet Piaget does not ignore discrimatory concept formation, although he does not use the classical language. He builds into his theory a component called classification which when examined closely is, in effect, discriminatory concept formation. Classification, which has its roots in the sensori-motor schemes, is concerned with sorting a set according to some attribute or determining whether a given object fits into a particular set. This is concept formation in the classical sense and is elaborately described by Inhelder & Piaget (1957).

Classification type concept formation tests

Bruner, Goodnow, and Austin (1961) made a thrroughstudy of concept attainment strategies on three types of concepts conjunctive, disjunctive, and relational. Their test consisted of 81 cards with four attributes, color, number, form, number of borders, with each attribute having three values. The cards were shown to the subject individually and after being shown some combination of positive and negative instances they were asked to determine whether a given instance belonged to the concept.

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Blackwell (1962) hypothesized that (1) changes in the mode of approach to a task of concept formation as a function of developmental level and (2) developmental differences in concept formation were response to variation in material. The subjects consisted of 70 children, ten in each of seven age groups. The subjects were tested individually with sets of material which was a modification of an instrument reported by Bruner, Goodnow, and Austin, (1961). Form I consisted of an array of geometric figures, composed of a combination of four attributes, each varying in two ways. Form II paralleled Form I except that human figures were used.

The results indicated that (1) the mean number of choices required to attain a concept is an inverse function of age, (2) the mean number of attribute changes is an inverse function of age, (3) the mean number of choices more like the original focus card than like any preceding card choice is an inverse function of age, and (4) the mean number of redundant choices is also an inverse function of age.

Yudin (1966) constructed a Brunerian type card-with-attributes test and presented them using 2" x 2" color slides. The test consisted of two instruction instances and six experimental concepts. Ten instances (each a single attribute) were presented for each concept. The subjects were 36 males aged 12, 14, 16 years old.

Berg (1948) devised a test of concept formation consisting of a pack of 60 response cards each containing from one to four identical figures of a single color. The figures were stars, crosses, triangles, and circles, and the colors used were red, yellow, blue, and green. Each could be sorted by the number, form, or color of the figures. There were four stimulus cards; first, one red triangle; second, two green stars; third, three yellow crosses; fourth, four blue circles. Reproductions of these cards appeared in the response pack and three of the response cards were duplicated.

The four stimulus cards were placed before the subject from left to right in the order given above. The subject was to sort the packet of response cards into four groups under the stimulus cards after which he was told whether he was right or wrong.

The Weigl-Goldstein-Scheerer Color Form Sorting Test has been used by several investigators. It consists of 12 plastic pieces, four each of squares equilateral triangles and circles which are red, yellow, blue, or green and on one surface but white on all others. The subject is asked to sort the objects into groups which seem to go together. Then he is asked to shift from color to shape or from shape to color.

Heald and Margolf (1953) used the W-G-S-C-F test to measure abstract behavior in 138 children in grades one through five. The subjects were pretested for color vision anomalies.

Weiss (1964) compared performance on the W-G-S-C-F Test to age and intelligence levels. The subjects were 71 children aged 8;8 to 14;5. They found a significant positive relationship betweeh total level of performance and age and intelligence. There was an abrupt improvement in performance at age 12.

Halpin (1958) used the W-G-S-C-S Test investigating the existence of a significant association between specific forms of color sorting behavior and CA or MA.

The subjects were 186 boys and girls aged 7-14 with IQ's from 40 to 70. The test consisted of geometrically formed pieces being placed on a table and instructing the subjects to "Put with each other all the pieces which are alike." The test was given individually, following the Goldstein-Scheerer procedure. Ability to shift voluntarily from one sorting category to another and explanation of the principle used was noted. Subject preference for color versus form groupings and instances of the use of pattern formation response on the first trial were also noted. Results indicated that neither preference for cateogrization by form or color nor the use of a pattern formation response is associated with CA or MA. Subjects with higher CA or MA showed a greater tendency toward shifting and in the total sample color tended to be used more than form. Huttenlocker (1964) investigated concept attainment under varing sequences of positive and negative instances. The test materials consisted of a box showing eight different geometrical shapes holes and corresponding blocks similarly shaped, black on one side and white on another. The box was rigged with light and buzzer to indicate a positive instance. The subjects were 300 children in grades 1, 3, 5, 7, 9, 11. They found that the (-, +) sequence was easiest with (+, -) and (+, +) being intermediate in difficulty, The (-, -) sequence was easiest. Furthermore they reported that negative instances cannot be handled as early as positive instances.

Maag (1957) developed a test to measure concept formation under stress. The test materials consisted of 32 small wooden blocks having 5 dichotomous characteristics: large-small, tall-short, round-square, hollow-solid, numbered-lettered. The test was administered individually to adults. E presented an exemplar of a two attribute class and S was to identify the seven correct members of the class from the remaining 31. S was told whether he was correct or not on each selection. The test was scored by counting the number of errors and recording the time to completion. The test was used for subjects in a stressful situation by having subjects learn the task to criterion and under normal conditions and retest under stress to determine effects.

Osler and Fivel (1961) investigated the effects of age and intelligence on concept attainment by induction. Subjects consisted of 60 children each in age groups 6, 10, and 14 and were divided equally into normal and high intelligence groups.

Two 3 inch hollow cubes were used with a stimulus card in a frame attached to each. The stimulus card not identified with the concept (bird, animal, living thing) differed from the card identified with the concept in the object belongingto the concept but was similar in all other respects. A marble was under the concept category cube. The task was to point to the cube containing the marble and the criterion was ten consecutive correct responses.

Results indicated that age and intelligence are associated with significant differences in errors to criterion and number of successful subjects. Frequency of "sudden" learners was a function of IQ but not of age and rank-order coefficients between MA and error scores were highly significant.

Bryant (1965) studied the transfer of learning by 40 retarded subjects whose ages ranged from 10 to 17 years and whose IQ range was 30-56. In both experiments the task was to sort cards differing in two dimensions on the basis of one dimension, size or shape. The first experiment investigated the effect of initial task instruction on transfer and the second experiment tested the ease with which positive and negative learning could be transferred. No significant differences were found in either experiment.

Tagatz (1969) investigated learning set and strategy interaction in concept learning using the Tagatz Information Processing Test (TIPT) and concept attainment tasks. Subjects consisted of 73 college sophomores.

The TIPT problems each contained an exemplar focus card plus an exemplar or non-exemplar. The subject was to determine inclusion, exclusion or indeterminateness of a third card's membership in a group with the focus card on the basis of this information.

The first and second concept attainment tasks were each composed of 20 problems containing an equal number of three-and four-attribute concepts to be identified by means of a stimulus display and commonality or conservative instructional stragegy. Tests were given separately to groups in booklet form.

Underwood and Richardson (1956) developed verbal materials for use in studying concept formation. They constructed a list of words, determining the frequency of response tendencies. If two or more words sometimes elicit the same responses, then these words can be used as the basis for concept formation tasks. Subjects were 153 adults.

Suppes and Rosenthal-Hill (1968) investigated concept formation using 50 kindergarten children who learned to sort cards according to one of 4 attributes on each of 3 dimensions. Geometrical cards had dimensions of shape (squares, triangles, circles, diamonds), border (striped, dotted, plain, filled with black ink), & color (red, blue, green, yellow). People cards depicted boys, girls, men, women, who were sitting, running, walking, or standing, & wearing yellow hats, blue coats, red scarves, or green jackets). For the first two sets of problems, information was presented to the subject by two positive examples. (Half the subjects had "geometric" rpboems first; half had "people" problems first). For both groups positive transfer occured from the first set of problems to the second, but problems to the second, but problems with "people" cards were more difficult than problems with "geometrical" cards. After reaching criterion on the first two sets of problems, subjects quickly mastered problems with a positive example and a negative one. An all-or-none model was found to be inadequate as a description of the learning process. Subjects achieved few correct solutions, however, before reaching criterion (4 out of 5 consecutive problems solved correctly for one dimension) and correct responses tended to occur in the last phase of the experiment.

Stone (1968) investigated concept attainment in a novel way. The task required the subject to place 54 blocks varying in color, size, and shape into a three-dimensional sorting bin containing 54 compartments. The three dimensions color, size, and form had to be taken into account simultaneously by the subjects.

Subjects for the study were 360 students in grades 1 through 9. Significant system differences began to appear at the sixth grade level, but overly "concrete" responses to selected attributes extended strongly into the ninth grade. It was found that discrimination training resulted in significantly increased scores.

In a study using the Hunter-Pascal Concept Formation Test, Pascal (1959) reported that the test appears to measure some aspects of cortical capacity not measured in the usual tests of intelligence. The subjects ranged in age from 4 months to 55 years. The test consists of nine problems (1) Immediate Reaction, (2) Delayed Reaction 1 (short), (3) Delayed Reaction 2 (long) (4) Delayed Reaction 3 (single alteration,cue (6) Double Alteration, (7) Serial Reaction 1, (8) Serial Reaction 2, and (9) Serial Reaction 3. The criterion was two consecutive correct trials for each problem.

Haygood and Bourne (1965) investigated concept attainment by having adult subjects classify visually presented geometric figures. They hypothesized that the complex concept attainment task can be separated into rule and attribute learning. By training subjects in each type as well as in both, they were able to compare the effectiveness of the methods. They found that rule learning was superior to attribute learning and that rule and attribute learning are independent components of conceptual behavior. It is important to note that Haygood and Bourne are making a distinction between two types of concept learning.where most investigators refer to just as concept attainment.

Thorndike, Hagen and Lorge (1968) have developed a Cognitive Abilities Test for use with primary school pupils. In reviewing the test, Cox (1969, p. 123) stated that the test was "...impressive with respect to adequacy of directions, general test design and norm data." However, the test lacks a theoretical basis. Furthermore, the test seems to resemble the intelligence tests designed for this level. It is questionable whether any clear cut concept formation tasks are utilized in this test.

Intelligence Tests based on Piaget's Theory.

Pinard and Laurendeau (1964) are developing an ordinal scale of mental development and consequently a standardized intelligence test. Piaget's clinical method is being incorporated. In a basic study, 700 subjects aged 2 to 11 years were individually tested. They are still in the process of developing the test at this writing.

Tuddenham (1970) is also attempting to develop a standardized intelligence test based on the theory of Piaget. He has centered attention on the transition from the preoperational stage to the stage of concrete operations.

The relation between intelligence and concept formation

There is poor agreement between researchers regarding the relationship between concept formation and intelligence. Some investigators, Goldschmid (1967), Bozarth (1968), Yudin (1966), Keasey and Charles (1967), and McManis (1969) find performance on conservation tasks to be either IQ or MA related. On the other hand Brison and Bereiter suggest that there is a low correlation between intelligence and intuitive concept formation. Freyberg (1966), and Duncanson (1966) also contend there is a low correlation between intelligence and concept formation. These studies are described below.

Goldschmid (1967) assessed the conservation of substance, weight, continuous and discontinuous quantity, number, area, distance, length, 2 dimensional and 3 dimensional space and their relation to age, sex, IQ, MA and vocabulary. Normal and emotionally disturbed children in first and second grades were the subjects for the study. Although the emotionally disturbed children were 2 years older, their level of conservation was not higher than that of normal children. In contrast, normal older subjects performed significantly better than normal younger subjects, even though their age difference was only 1 year. Conservation was positively correlated with IQ, MA, and verbal ability. An analysis of nonconservation responses suggested an interaction effect between the frequency and the type of nonconservation, on one hand, and the particular task and configuration of the manipulated object, on the other. The results both support Piaget's theory of age-dependent cognitive development for normal subjects and suggest significant individual differences with a given age group.

Yudin (1966) studied formal thought in adolescence. The subjects for the study were 36 males aged 12, 14,or 16 years who were divided into three groups by IQ. Only those with achievement commensurate with IQ were selected.

Subjects were shown 2" x 2" color slides and were presented with two instruction and six experimental concepts. Ten instances (each a single attribute) were presented for each concept.

Results indicated that the number of instances required decreases with age, the percentage of incompatible strategies decreases with age, the number of ideal and compatible strategies increases with age, IQ is significantly related to fewer instances to attain concepts, lower IQ is not significantly related to greater perceptual errors, and development of cognitive functions in adolescents of different IQ does not follow identical patternsnor become manifest at identical periods.

Keasey and Charles (1967) studied the conservation of substance in normal and mentally retarded children. The purpose of the study was to investigate whether two groups of children with the same MA's, but with varying amounts of life experiences would differ in their understanding of conservation of substance. The subjects were 21 mentally retarded children with MA between 5-3 and 10-10 and CA's between 13-0 and 28-8 paired with 21 children whose MA's were within 6 months of their CA. Six conservation of substance tasks were administered to the 42 subjects in individual sessions. Although the subjects in the retarded group had lived an average of 11.41 years longer than the normal subjects with whom they were matched, Keasey and Charles found that they had no better grasp of the concept of conservation of substance than the normal subjects with whom they were matched. However, understanding of the concept correlated very highly with the mental age of the subject.

McManis (1969) explored the conservation of mass, weight, and volume by normal and retarded children. 90 normal and 90 retarded subjects, matched for MA between 5 and 10-11, were tested for conservation of mass, weight, and volume of clay using Piaget's "sausage" experiment. The results showed conservation to be MA-related and in the difficulty order of mass, weight, and volume, although reversals in order occured for some subjects. Normals generally had higher mean conservation scores than retardates, but their MA-placement for the tests by percentage of subjects succeeding (70%) corresponded. Prediction responses were found to be poor indicators of conservation for.low MA subjects.

Brison and Bereiter (1967) studied the acquisition of conservation of substance. Forty-five kindergarten and grade 1 children were subjects for this study, 15 at each of the IQ levels of gifted, normal and retarded. Results showed that all three groups were equivalent in the attainment of conserving responses and transfer to new material. While differences existed between groups on intelligence, they all learned conservation equally well. This study shows that there may be a low correlation between general intelligence and intuitive concept formation.

Freyberg (1966), investigated the relationship between level of concept development and school attainment in arithmetrical computation skills, in solving arithmetical problems, and in the verbal field in spelling. The subjects were 151 children aged 6 to 9 years in a New England city of 42,000.

A 72 item objective test of concept development was first devised and evaluated. The attainment tests were a 120 item arithmetic computation test, a 25 item arithmetic problem solving test, a 22 item spelling test, and a PMA intelligence test.

The study indicated that concept development is more closely linked to growth of general intellectual ability than to CA alone. It also suggested that school performance appears to be associated with aspects of conceptual thinking not adequately assessed by conventional intelligence tests.

Duncanson (1966) investigated the interrelationships among measures of learning and measures of abilities by administering a battery of ability tests and learning tasks to 102 sixth grade children. Learning tasks included concept-formation (adapted from Wisconsin Card Sorting task) (Berg, 1948), paired - associate, rote-memory tasks with verbal, numerical, and figural material Ability scores and measures of learning were factor analyzed and 7 factors extracted. One factor was restricted to the ability measures, 3 restricted to learning measures, and 3 common to both. It was concluded that performance in a learning task is related to measured abilities and to performance in other learning tasks and that there are learning factors which are not related to the abilities measured. Concept-formation factor and the verbal and nonverbal learning factors are independent. The concept-formation tasks used were found to be unrelated to the other learning tasks and to the abilities measured. One possible reason speculated is that the tasks called concept formation were rather specialized tasks requiring fairly specific abilities which may or may not be the same as those required in the usual scholastic or intellectual tasks thought of as "concept formation".

Socioeconomic status and level of cognitive development

Bozarth (1968) examined the relationship between socioeconomic status, (SES) conserving status, achievement and intelligence of 209 fourth-grade children. He found that there was a significant difference between high and low SES levels on conservation of liquid quantity in favor of high SES. He further reported that conservers generally had higher intelligence and better achievement in school science.

Wei (1967) studied differences in classificatory performances of socially disadvantaged children with those of middle class children at the kindergarten and grade 2 level. The Subjects were 80 white children in 4 groups of 30 each and 20 Negro children. The materials were 4 classification tasks. Changing criteria, object classification, class inclusion, and matrices. The Subjects were individually tested. Wei found that the ability to classify increases with age and both kindergarten and grade 2 children of the cultural deprived group scored lower on tasks of classifications than do middle class children. Piaget's theory states that there is a sequence in logical development and that stage development is related to CA. This is supported. This study supported Piaget's theory of equilibration which stressed the continual interaction between individual and environment. Opportunities for such interactions are often missing in deprived environment and may contribute to the differences in the levels of development.

Skypek's (1967) study measured differences in the development of cardinal number conservation concepts among children from differing socioeconomic environments. Three Piagetian conservation tasks of discontinuous quantity, provoked correspondence, and spontaneous correspondence were the critera used. The subjects were 120 students selected randomly from kindergarten, first, and second grades in 4 schools in a metropolitan school system. Schools were selected according to the socioeconomic status of the urban neighborhoods they served. The relationship of socio economic status to concept-test scores was highly significant with differences favoring middle class. All subtests were significant except conservation of spontaneous correspondence. The relationship of CA to concept test and subtest scores are highly significant with differences favoring children from successively older age groups. No significant difference was found for race, except on the conservation of provoked correspondence (favored white). For the middle class sample, correlations of age and score were positive and significant for all three conservation subtests, following Piaget's theory. The developmental pattern of cardinal number conservation for the low status Ss was erratic. Only 53 of the 120 subjects were in the same stage on all 3 tasks. Among low status Ss a discernable but erratic pattern of retardation in the development of number conservation concepts was noted.

Farnham-Diggory (1969) experimentally analyzed the ability to integrate information when "triggered" by symbolic cues in three types of situations: verbal-integrating actives with logographs, maplike-integrating spatial ideas, and mathematical. The subjects were 212 Negro and White children aged 4 to 9 years.

A normative study was made of the effects of age, sex, race, and socioeconomic status on the three kinds of synthesis. A training study, utilizing Negro ghetto subjects only, assessed effects of four training conditions on verbal synthesis in 5-year olds; three training conditions on maplike synthesis in 7-year olds; and two training conditions on mathematical (ordering) synthesis in 4-year olds.

The results indicate that, in general, Negro children have special difficulty with spatial and mathematical synthesis, but are superior in verbal-action synthesis in comparison to White children.

Thus, there seems to be a difference in concept formation ability of different socioeconomic status children in favor of middle class children. The results are not clear cut however. There may be factors in the assessment procedures which favor the middle SES group such as language use. If differences can be established unequivocally, then the exact nature of the differences and contributing factors must be identified.

The perceptual-cognitive shift

Several investigators have explored the shift from a perceptual focus to a conceptually dominated pattern of thought. This usually occurs about age 7 as the child is developing concrete operational thought.

Sigel (1969) investigated changes in abstraction ability during the elementary school period utilizing 60 lower middle class Whites as subjects. There were 20 subjects each of age 7, 9, and 11 years.

Five tests were administered, each containing 24 familiar toy objects, pictures of these toys, and word names of the toys. Subjects were instructed to group the materials on the basis of similarity. Categories used by the examiner were perceptual, conceptual, and miscellaneous.

Results indicated a decrease in perceptual classification of items and an increase in conceptual classification with age. Nine and eleven year olds increased the use of miscellaneous groupings when asked to reduce the number of groupings.

McConnell's (1963) study is a comparison of younger and older children in their use of perceptual cues as a basis for mediation and in their preferences for perceptual versus verbal cues when these are in conflict. The subjects were 55 nursery school children and 75 second grade children. The stimuli used were cylinders varying in size and brightness. Independent groups received the following treatments at each age level: (1) size arrangement, (2) brightness arrangement, (3) simultaneous size arrangement and brightness verbalization, (4) brightness arrangement and size verbalization simultaneously, and (5) random arrangement and no verbalization. The results show that both younger and older children responded in a mediational manner to perceptual arrangements; (2) interference was stronger for younger children when irrelevant dimensions were perceptually emphasized; (3) older children were more influenced by relevant verbal cues; (4) when relevant verbal cues were pitted against irrelevant perceptual cues the former were dominant with the younger children; and (5) younger children favor perceptual mediation while older children favor verbal mediation.

Halpern's (1965) study investigated competing perceptual and conceptual cues in problems of inference of measruement. The subjects were 20 five to seven years of age. Half of the subjects were empirically oriented and half were deductively oriented. As predicted, the empirical group made more errors than the deductive group on 36 problems of inference of measurement and a higher proportion of the former's errors were made where perception directly contradicted logic. The data suggest that perceptually bound modes of thinking are still used in certain situations even after conceptual thinking is manifest. Perception is misleading even in the presence of conceptual thinking.

Poteat, and Hulsebus (1968) suggested that the vertical dimension is a significant cue in the preschool child's concept of "bigger". The hypothesis tested is that 5 and 6 year old preschool children when asked to choose between geometric solids will select as "bigger" those objects having greater verticality. For each pair of solid, three-dimensional objects in 8 displays, the subjects indicated the "bigger" figure to be the solid having the greater vertical dimension ($p < .001$). For all of the displays, the choice pattern differed significantly from those of a control group of 25 college freshmen. Results suggest that the vertical dimension may be the salient misleading perceptual cue in the studies of conservation.

Assessing Concept Formation

The scalability of conservation tasks

Scalogram analysis has been used by several investigators to determine the relationship between different types of conservation tasks.

Uzgiris (1964) investigated the influence of situational variables (materials used to test for the attainment of conservation) on the sequential development of the conservation of substance, weight, and volume as proposed by Piaget. The subjects were 120 grade school children. A scalogram analysis indicated that conservation of the three quantities is achieved in the above sequence on each of the materials.

Davol, Chittenden, Plante, and Tuzik (1967) investigated the acquisition of conservation of continuous liquid quantity. Thirty children (grades K-3) were administered 15 problems, all related to the acquisition of conservation of continuous liquid quantity, from which 10 scalable items were derived. In a scalogram analysis, Jackson's Plus Percentage Ratio and Green's Index of Consistency indicated that the items formed a scalable set. Ability to pass the more difficult problems developed rapidly during the age period covered. In line with Piaget's analysis of concrete operations, the results suggested a shift in orientation towards the problems occured during the first- and second-grade years.

Siegelman and Block (1969) developed two parallel sets of scalable items. The data reported by Smedslund for his tests of concrete reasoning, given to 160 subjects aged 4 to 11 years, were submitted to scalogram analysis. When one item was dropped the remaining eight were found to constitute two parallel forms with satisfactory scalability as assessed by two scalogram indices. The two scales are functionally similar. In addition, the order of items on the two forms is in accord with the body of theory and research on the development of concrete operations.

The purpose of a study by Phillips (1968) was to investigate a portion of a proposed model for the acquisition of the concept of volume displacement and to compare two methods of conservation task presentation. The proposed model was a result of a pilot study.

Subjects for the study were 40 students from each of 3rd, 5th, and 7th grades in Tallahassee, Florida. All subjects were given the same tasks in individual interviews but each subject was assigned randomly to either an "object" presentation or a "graphic" presentation.

Results of a scalogram analysis of task scores supported the conclusion that the tasks used in the study were attained in the sequential order predicted by the model. There were significant differences in task attainment by grade level but not between the two methods of presentation.

Eleven classification tasks were subjected to scalogram analysis. No clear cut evidence for a unidimensional scale was found. Only 27% passed all items up to a point and then failed all others. Subjects were 122 children ages 4 to 9 years. Tasks were developed that required Ss to demonstrate their understanding of each of the 11 classificatory operations by correctly manipulating a set of geometric blocks. Tasks were administered individually in a random order.

In general, the conservation tasks have been shown to be scalable.

Experimenter variables in concept testing

In constructing a test of concept formation, particularly one which incorporates the conservations, it is imperative that bias due to the testing situation be eliminated.

Bittner and Shinedling (1968) studied methodological problems in measuring conservations of substance in children. The Subjects were 8 male and 8 female S for each of two experiments. Some rather striking results were reported. For first-grade Ss instructional and task variations influence performance; for third-grade Ss the importance lessons. For first-grade Ss the sex of the experimenter was a major source of variation. Female experimenters elicit the best performance for first-grade Ss, but the reverse is true for third-grade Ss. This study deserves replication in light of the small number of subjects. The findings, if true, are of major importance for testing of the conservations.

Hall and Simpson (1968) studied factors influencing extinction of weight conservation. In an experiment with 40 second-grade subjects, they found no support for the hypothesis that the age or type of presentation made any singificant difference.

Uzgiris (1964) investigated the influence of situational variables (materials used to test for the attainment of conservation) on the sequential development of the conservation of substance, weight, and volume as proposed by Piaget. The subjects were 120 grade school children. The finding that variation across materials is greater at some age levels than others suggests that a relation between situational variables and conservation behavior may be most wide during the formation of a conservation schema.

Siegel and Goldstein (1969) tested the understanding of relational terminology and conservation of number. The subjects were 66 children, aged 2-7 to 6-1. Until the age of 4-7, most children do not respond correctly to quantitative relational terms such as more, less, and same. Most children younger than 5-7 do not have conservation of number. Instead of choosing the correct relational alternatives or showing conservation of number, younger children systematically exhibited recency response strategies by choosing the last of two alternatives offered them.

Rothenberg and Courtney (1969) attempted to provide information from an analysis of various types of transformations, on what aspects of these transformations are attended to by nonconserving children. 286 children, ages 2-5 to 6-2, were the subjects in this study. The ability to understand the necessary language was first assessed. Then five test transformations were presented (equal subtraction, rotation, equal addition, expansion, collapsing). According to subjects answers to questions asked, they were classified as conservers, consistent nonconservers, or inconsistant nonconservers. The significant results were: The row on the subjects' side was clearly chosen more frequently as having more blocks than the one on the E's side. ($p \leq .001$), especially among younger subjects. Oldest subjects tended to choose the longer row when this dimension was available. Lower SES *S*s tended to choose rows on the basis of closeness and sometimes also manipulation, while middle SES chose the longer row. Consistent nonconservers were more likely to use length as a criterion of "more", while the inconsistent nonconservers used closeness. (Selection of the closer row is an early developmental phenomenon not usually seen). Among older nonconservers, length is clearly the most important choice of a row with "more" with factors of manipulation, closeness, and density in order of decreasing importance in influencing the nonconserver's choice.

Peters (1967) investigated task variations and individual differences in Piaget's conservation of number. In this study, two trends of thought were followed to the same culmination, First, the materials and procedures used in the conservation of numerical correspondence task were viewed as unacknowledged possible sources of variations in currently reported findings. It became evident from the review that an explanation quite different from Piaget's was possible concerning children's progression through the stages leading to conservation. Evidence indicated that the child in the transition stage already possesses the notion of equivalence, but lacks the knowledge of the appropriateness of the number cue dimension in the test situation. For such a child the distinctiveness of the relevant cue (number) as compared to the irrelevant cue (length) is of importance. If the cues are distinct, the transitional child will display conservation if the situation is such that he attend to the number dimension. Changing the predomination of relevant and irrelevant cues changes the likelihood of the performance. This hypothesis needs confirmation by systematic study. Secondly, it was hypothesized that support for the above analysis and knowledge of an additional source of variation would be gained if children who achieved conservation could be shown to differ from those who had not in skills, styles of problem solving and personality traits that would be conducive to the cue discrimination required by the conservation tasks. The literature suggests resistance to distraction, independent of adults, sociability, assertiveness, an analytic attitude, longer attention span, persistence in tasks, and impulse control. Some support for this hypothesis was provided by a limited test.

Hall and Kingsley (1968) criticized the methodological techniques of assessing conservation and found that children in the intuitive phase are very susceptable to experimental suggestion. They report that this can be overcome by using tape recorded verbal instructions.

Fletcher (1967) investigated the extent to which language is a factor in conservation of number. The subjects were 200 first graders. Responses to traditional conservation of number questions and questions employing an operationally-defined coined word "bimates" were compared. Subjects first received training in the meaning of "bimates." The test consisted of seven equivalent and seven non-equivalent sets of conservation of number problems. The test employed 14 separate devices. Group I subjects were asked "Is this bimates?" Group two was asked "Do we have the same number of red cards and blue cards?"

Results from each test indicated that language plays a part in the conservation problem, but in no test were there significant differences between responses to questions phrased in the two ways.

Braine (1968) takes issue with Piaget on his experimental procedures and especially his use of verbal techniques in testing subjects. In several studies selected to test Piaget's methods Braine found that when nonverbal methods were used, the concept of transitivity of length appearsin children fully two years prior to the age found by Piaget's five years instead of seven years. There is a serious question as to whether Braine's nonverbal techniques using rewards for selected responses actually assesses the concept. He has shown that Ss can learn to make certain responses but is is not clear that he has adequately tested the concepts.

In another study on conservation of size, Braine (1965) used materials to create illusory effects on size of objects. In one instance he asked, "Which is bigger?" and in another he asked, "Which is really bigger?" Using 55 children age 4-1 to 7-5, he found that by 5 years of age a majority of children were able to make a distinction between real and phenomenal size. Braine's findings contain much artifactual data. There is a strong suggestive effect when one asks, "Which is really bigger?" The child is quite likely to reverse his position under such questioning. The findings of Bittner and Shinedling (1968) on methodological problems apply to Braine's study.

Silverman and Schneider (1968) investigated the development of the conservation of quantity by a procedure adapted from Piaget's but with a criterion other than verbal report. (The method did not depend upon the child's statements of "more" or "less". The subjects were 147 children aged 4 to 10 years, 66 male, 81 female, from lower and middle class families. The child was shown identical glass jars with different amounts of M and M's and asked, "Which jar has more candy?" Then as the child watched, the experimenter poured a lesser amount into a third jar, which was longer and narrower and placed it next to the jar having the greater amount. Then the experimenter said, "You can have all the candy in one of these jars, whichever one you choose. Which one would you like?" Then, "Why did you pick that one?" The percentages of children at one-year age levels showing conservation conformed closely to Piaget's reports and subsequent replications which used verbal methods. The sex differences within age groups did not achieve significance, there was a trend which suggested that females may develop conservation earlier than males.

Wheeler and Ginsberg (1969) investigated Piaget's explanation of failure to conserve discontinuous quantities. Piaget's explanation involves certiation. Alternative hypotheses attribute the failure to conserve either to poor linguistic ability or inadequate motivation. The study gives a direct comparison of the two points of view.

A non-verbal motivating assessment procedure, employing the legitimate non-conservation problem, failed to show greater success in 40 non-conserving four year-olds (mean age 4-7) than a standardized version of Piaget's clinical method. Results were interpreted as supporting Piaget's position.

Griffiths, Shantz, and Sigel (1967) studied the use of relational terms. This study was concerned with the ability of preschool children to use the relational term "more," "same," and "less" when comparing the number, length, and weight of objects. The availability of these terms as spontaneous or elicited responses also was assessed. In general, children had most difficulty using the term "same" correctly. They had least difficulty correctly using all terms in length comparisons. For number and weight, the correct use of the terms was most often an elicited response; for length, children tended spontaneously to use the terms correctly. Thus, questions are raised about the appropriateness of verbal questioning of subjects without first assessing their knowledge of the relational terms used.

A test of conservation

Goldschmid and Bentler (1968) have published a conservation test in three forms. The test utilizes manipulative materials which are available together with the test as a Conservation Assessment Kit. As an individually administered test, it measures conservation of number, length, continuous quantity, mass, area and volume. Forms A and B consist of 12 items each. Form A and B can be used as pre- and post-tests while Form C can be used as an indication of the generalization of conservation. A significant finding is that children's more, less or same responses correlate above .90 with their explanations. Thus, it would not seem necessary to utilize the easily misinterpreted verbal explanations of children in assessing conservation.

DeVries and Kohlberg (1970) raised a question as to the advisability of using a 12 item test to establish the presence of operational thought.

The role of surprise in assessing concept formartion

Charlesworth (1969) suggests that concept formation and concept development can be effectively studied by using surprise. By presenting a situation where a particular concept such as conservation might lead the subject to predict a certain outcome and then, using subterfuge, change the outcome, much can be learned about the possession of the concept. He suggests, in such a situation that we monitor the subjects, neurophysicalogical changes using, for instance, the GSR. If a subject has the concept he will expect a certain result. If he does not have the concept, no link between stimulus and response is expected. Thus a subject will show surprise if and only if he understands the concept. This approach seems to eliminate many research problems in other types of testing such as bias due to perceived expected response and the language problem. This is an exceedingly promising procedure.

In an empirical test of this procedure, Charlesworth (1964) usedchildren ages 4-8 years. The subject's task was to put a specified set of colored marbles into a container, leaving a similar set behind in a trough as a memory aid. The container had 2 spouts into which marbles could be inserted then poured. Marbles inserted would roll into the view of the subject and then out of the container through a delivery tube controlled by the experimenter. From the subject's point of view, the law of conservation of substance was apparently violated whenever output marbles differed in color and number from the input marbles. The subject responded to the first marble from the output by pulling a lever designated with the same color. When he pulled the lever a timer recorded the response latency. A second timer recorded the time it took the subject to pull the lever the whole length of the lever track. One group had output marbles the same color as the input (no surprise) and one group had output marbles that were never the same as the color of the input marbles (surprise). All the subjects were between 4 and 8 years of age. Subjects in the surprise group showed longer latencies in responding. One conclusion was that latency of response could be used in subsequent studies as a potential indicator of the presence or absence of certain cognitive structures which would predispose an individual to expect one event rather than another. The surprise group also stayed in the game significantly longer. These findings were interpreted as supporting the notion that surprise as a stimulus producing response can motivate curisity behavior and can be viewed as playing an important role in cognitive development.

Group testing of concept formation

Many researchers investigating the Piagetian conservations have used an individual testing procedure patterned after the clinical method of Piaget. They have generally employed physical materials which can be manipulated and they have usually established a standard testing procedure acceptable for experimental research. Although Goldschmid and Bentler (1968) have developed a standardized conservation test using manipulative materials, individual testing is very descriptive and time consuming. If feasible, it would be most desirable to have available a group test for assessing children's concept development, in particular the conservations.

Nelson (1969) developed a group test for assessing number and length conservation with first-grade children. He utilized an overhead projector for presenting items and the pupils marked their answers in response booklets. The correlation of scores on this test with scores on an individually administered test of the same concepts was .51. This approach seemspromising.

Becker (1969) found no significant differences between individual and group scores on four selected standardized psychoeducational tests. Subjects were 169 kindergarten, first-s, second-, and third grade pupils. Items were presented by projecting designs on a screen using transparencies or by use of a closed circuit television system. This study lends support for the use of group testing of children on cognitive variables.

Brown (1967) developed, a reliable group test of children's ability to conceptualize. The test was prepared for use in a elementary science curriculum project. The test measured its ability to attend to a task, to remember logically, to detect similarities and to use all these skills in the conceptualizing process.

Delacy (1967) administered a group paper and pencil test of Piaget's length conservation task to 140 children aged 6-12 years with 10 boys and 10 girls at each age level. Two three-inch reference lines were given on cardboard and the subject was given paper to see if the lines were equal. Next, four plastic sheets of Mueller-Lyon illusion arrowheads (45°, 55°, 65°, 75°) were used, one at a time, to distort the equality. There was no difference in the degree of illusion created by the various arrowheads. The subjects could not reliably conserve length with this test until 12 years old. Some inversion of performance was noted for the ten-year-olds and this was explained in terms of shift from iconic to symbolic reasoning.

In light of the literature on this subject, it would seem desirable to standardize the testing procedure. As we have seen, there aremany sources of variation in the experimental procedure. If the entire test could be administered using sound film, these sources of variation could be controlled. Further research is needed, however, to show that such a procedure is valid.

Projection techniques in presenting concept formation tasks

O'Bryan (1969) prepared a 16 mm. film test of length, area, continuous quantity solid, and continuous quantity liquid. Subjects were 80 first grade pupils. The basic conservation question was tape recorded but subsequent follow-up questions were asked by the experimenter. A child was judged to be a conserver only if he gave a solid reason for his correct response. Otherwise he was classified as a nonconserver. By insisting that Ss give reasons for their answers, O'Bryan introduced a source of variation. It would seem more advisable to devise a test which was standardized throughout and did not rely on evaluation of Ss oral responses. Some Ss may fail to give acceptable responses because they are shy. Comparisons were made between the usual method of individual testing with manipulative materials and the film presentation. No significant differences were found between the two methods of testing conservations. Along with (Singh, 1968) this study provides strong support for use of filmed presentation of conservation tests.

Yudin (1966) constructed a concept formation test a la Bruner, Goodnow, and Austin (1961). The items were presented using 2" x 2" color slides.

Nelson (1969) devised a test of number and length conservation using an overhead projector to present items. The results of this method of presentation with first-grade pupils was satisfactory.

Sullivan (1967) explored the use of film modeling techniques. The subjects were 100 grade one boys and girls. This study established that conservation of substance can be induced using film modeling techniques. The Subjects observed an adult giving correct responses to conservation of substance questions. The results seem to elevate the importance of language and depress the effects of action, particularily inter communication with adults leads to a reorganization of the child's processes. This is contrary to Piaget's position.

The filmed presentation with taped instructions seems to be the most promising new method of presenting concept formation tasks. One particular advantage of such an approach is that the test could be administered by relatively unskilled examiners.

Language Development
Literature Review

Verbal skills required for adequate school performance in elementary school children from lower socioeconomic backgrounds have been found to be disturbingly lower than their middle-class counterparts. Of special interest are the language development interrelationships among Negro, Spanish American and other White.

A number of investigators have attempted to explain the depressed performance of disadvantaged ethnic subgroups.

Language Development in Negro Children

Recently Joan Baratz (1969) has offered a summary of the main viewpoints which relate to the language-functioning of economically disadvantaged Negro children. There is considerable overlap between the generalizations of Baratz and those of Frazier (1965). The bulk of the indented material which follows is directly from Baratz.

1. Many such children are verbally destitute, that is, they have not yet developed a functionally adequate, or structurally-systematic language code (Raph, 1967; Metz, 1966). Generally, such studies tend to explain the absence of language development in the child with regard to such environmental factors as limited mother-child verbal interaction (Milner, 1951; Radin and Kamii, 1965), noise in the environment (C. Deutsch, 1965), and sensory-social deprivations. Standard English has been the criterion upon which the language underdevelopment studies rest.

2. Such children have systematic, but underdeveloped, language behavior which accounts for their poor school performance, since command of the major American dialect is essential for adequate school performance. In addition, their underdeveloped system leads to cognitive deficits (Bereiter, 1965; Bernstein, 1960; Deutsch, 1967; Hess, Shipman and Jackson, 1965). The assumption of these studies is not merely that different speech systems create different cognitive patterning-- the time honored Sapir-Whorp hypothesis -- but in addition that these various speech systems can be ranked hierarchichally according to abstraction and cognitive complexity.

3. While there are some linguistic differences in the dialect of these children, they are probably not sufficient in themselves to explain their depressed performance. What these children lack is a language environment which exhibits

and reinforces certain manipulations of language, e.g. cause-and-effect relationships, sets and sequences, wide-ranging vocabulary, classificatory behavior, overt planning, self instruction, etc. (Silvarski and Wakefield, 1970; Green, 1970).

4. These children have a fully developed, but different system from that of standard English (Bailey, 1967; Dillard, 1967; Labov, 1965; Povich and Baratz, 1967; Stewart, 1965, 1967, 1968). These studies do not question that the child has learned a language or that he can use his language to think abstractly. These researchers see the language problem of Negro ghetto children not as one of linguistic competence but rather as one of linguistic interference between standard English and their own highly developed system, Variousl called Black English, Negro dialect, NNE (non-standard Negro English, or Normal Negro English).

Spanish-American Children

For Spanish-American children of low socioeconomic status, some of the same explanations have been proferred (Thomas, 1970). Few investigators suggest, however, that they are verbally destitute (although Tex-Mex dialect has been occasionally termed "non-lingual"); some contend that Spanish-American children are essentially on a par linguistically with middle-class children (Anastasi and deJesus, 1953 -- referring to New York Puerto Rican children), and more believe that there is some degree of linguistic inference (Perales and Howard, 1970). Since the "linguistic distance" between Spanish and American speech (Standard English) is said to be greater than between NNE and the major American dialect (Standard English), researchers vary on their estimates of how much or how little difficulty these children will encounter when faced with acquiring the school language.

Investigators also vary on the dialect features which are shared by Anglo, Negro, and Spanish-American individuals living in the same, or adjacent neighborhoods (Lance, 1970).

Carl Rosen (1969) has carefully shown the lack of reliable data on the major variables of language/dialect/populations and sub-populations of so-called Spanish-Americans. Consequently, he reiterates that precious few generalizations can be made with regard to these children.

There are problems of subgroup inclusion within the larger group labelled low SES. What is designated here as Spanish-American, presumably includes Puerto Ricans, Mexican-Americans, Cubans, and, the small percentage of former residents of Spain and South American countries as well. However, Rosen and others have cautioned against lumping all Spanish-speaking or Spanish surname children together. Still other researchers warn against grouping all Blacks together (Stewart, 1969) or Blacks and Puerto Ricans (Mattleman, Marciene, and Emans, 1969) or in referring to all lower-class Whites as though they represented a homogeneous group.

Non-Negro, Non-Spanish-American Children

There are a few studies which single out non-Black, non-Spanish speaking children. Two examples are found in the recent work of Entwisle and Wakefield. Entwisle (1968) concluded from responses on a word-association task that White urban slum children are more advanced in linguistic development than White suburban children of the same intelligence level. Wakefield (1969) analyzed the frequency of oral use of ten basic English sentences, as well as four types of mazes (pauses, interruptions, false starts, etc.), and found no significant difference among first graders comprising three ethnic groups of the same low SES level -- Negro, Spanish surname, and Anglo. She suggests that these children have approximately the same language patterns in English.

However, only occasionally is this subgroup carefully defined- e.g. Appalachian children, poor Southern Whites, rural Northern Whites, urban Whites. More often these children are grouped with other low SES children on an undifferentiated basis.

Disadvantaged Children

Usually then, low SES children are grouped together, and on the traditional language measures are typically found deficient: in vocabulary (Carson and Rabin, 1960; and others); in sentence length (Thomas, 1962; Jones, 1966); in articulation (Templin, 1953; Klaus and Gray, 1968); in grammatical development (Osser, Wang and Zaid, 1969). However, findings are not all in that direction. Strengths, or at least an equivalent performance, has been found by a number of investigators. For example, in the usual uses test, lower SES children were found to be superior to middle-class children. In a study by LaCivita, Kincaid and Yamemoto (1966), no SES differences were found in a task which required subjects to guess the meaning of a nonsense word imbedded in a sentence, and marked linguistically to suggest form class (noun, verb modifier). Two other studies (Katz, 1967; Ruddell and Graves, 1968) suggest that when lower SES children and middle-class SES children are presented with equally unfamiliar verbal stimuli, there are no significant differences between performance of the two groups.

Standard English of course, has most commonly been the language form within the measure used to assess the verbal repertoire of the American school child. Examples include: picture vocabulary tests, (e.g., Ammons, PPVT) sections of the Binet and WAIS, ITPA, various preschool inventories and readiness tests. There are a few exceptions. In a study by Deutsch, Levinson, Brown and Peisachi (1967), children were asked to listen to and fill in missing words from samples of teachers' speech and two socioeconomic levels of children's speech. Using this cloze procedure, it was found that higher SES children performed equally well on same status peer speech, as on lower SES children's speech; whereas, the low SES subjects did more poorly on the higher SES peer speech. Williams and Wood (in press, 1970) found similar results using teenage Negro girls from a poverty school and girls of a middle-class area school. Again, the higher SES level students were equally able to approximate the language of their age group peers regardless of SES level. By contrast, the low SES teenage girls were better able to approximate the language of their own SES peers than that of higher SES peers. These last two studies used some aspects of the community dialect; that is, the children were invited to speak informally. It may be that the investigators got a fair sample of the low SES primary code, although some critics doubt that the low SES children spoke in a fully familiar fashion in the experimental situation.

Harms (1961) got similar results using adults. Subjects of varying social strata hear short recorded passages delivered by speakers of the same varying social strata. Like Deutsch, et al. and Williams and Wood, word predictability in a cloze procedure was used, and results indicated that listeners were most successful in comprehension when responding to speakers of their own status rating.

Baratz (1969) has attempted a direct comparison between the two codes of NNE and SE in elementary school children. She presented disadvantaged third and fifth grade Negro and lower middle-class White children with a repetition task which involved standard English sentences and NNE counterpart sentences. She found the Negro children performed significantly better than White on the NNE stimuli. The converse was true for the standard sentences. She concludes that Black children are generally not bi-dialectal and that there is evidence of interference from their dialect when Black children attempt to speak standard English.

Educational implications

From the research which preceded compensatory programs, it was assumed that various kinds of experiences would help to overcome the educational deficit, and most particularly the language deficit, of these subpopulations of children. Some head start programs used traditional nursery school enrichment curricula, while others employed a wide variety of "highly structured" preschool programs. In general, the implicit assumption was that these children were essentially language deprived, and consequently needed to learn a language, or, as indicated earlier, that they had a language but it wasn't very useful for school demands. General and specific stimulation in standard English was incorporated into most programs.

The success of past compensatory programs has been questioned. Evaluations range from failure (Jensen, 1969) through temporary modest success (Klaus and Gray, 1968), through success with delayed effects (Morris and Harris, 1970). Overall research designs have come in for a great deal of criticism. The problems of useful measures, time span of the intervention program, degree of involvement of parents, etc., have all come under fire.

Very few of the language sections of the projects used contrastive analysis, a practical teaching concept which is an outgrowth of the linguistic interference model. This approach is currently being used by Baratz at the Education Study Center in Washington, D. C. Contrastive analysis is intended to help the child notice specific differences between his dialect and the major dialect. These contrasts are of a syntactic, morphological, and phonological nature and the children are encouraged to value as well as practice both linguistic systems. Thus, the linguistic interference model carries with it direct implications for changes in the schools; for example, teaching in the vernacular which has been advanced by a number of investigators as far back as UNESCO 1951 report. Since that time a number of studies inside the U.S. (Richardson, 1968; Erickson, 1969) and outside the U. S. (reported in John, Horner and Socolov, 1969) have shown support for this possible change in curriculum. Language specialists of this persuasion are adamant that teachers be aware of differences in dialect, that they value and appreciate these differences, and that they build on existing language and culture styles (Bailey, 1970).

Motivation

The Coleman report (1966) emphasized that children's sense of control over their environment and self image correlated highly with school achievement. Consequently, a great deal of concern has been directed at language development as part of the subculture. Minority group children, particularly of low SES level, have been described as alienated from school, so that a valid assessment of their cognitive abilities becomes difficult to achieve since many are unlikely to give their best effort in the school environment. Black children in general have the feeling of external locus of control, that is, that what happens is determined in a large part by factors outside their control. Many Spanish-Americans tend to view events as the will of God, are generally non-competitive, and have a casual attitude toward time (Hernandex, 1968).

It has been suggested that there are ways in which an investigator can attempt to enhance the performance of these low SES children. Since race of the examiner evidently has an effect upon their task performance (Katz and Greenbaum, 1963; Baratz, S., 1967; Smith and

May, 1967), same-race examiners should be used whenever possible. Offering concrete monetary rewards might maximize performance (Effrat, 1969). In fact, monetary rewards are currently in use in some projects. College students from low SES backgrounds are being paid five dollars a week to attend classes in an upstate New York program (B. Mueller, personal communication). Film or TV presentations may well increase attention and subsequent performance, as Sesame Street staffers believe. As mentioned before, if presenting these children with equally unfamiliar verbal stimuli tends to reduce the gap in performance between low SES children and higher SES children, these kinds of tasks should receive further study.

The above listed variables are of importance to this particular project, since some aspect of the linguistic interference model appears to be worth measuring. If the task could be presented on film, it would be ideal both for attentional factors and for standard presentation reasons. In addition, those factors which would tend to maximize performance, e.g., same-race examiners; monetary reward for correct responses; non-school locale to attempt to counteract the alienation of the general school environment, etc. should be included in the design where feasible.

Logical Thinking
Literature Review

Theoretical viewpoints

Studies of logical thought development have focused on a myriad of aspects, but most researchers have investigated isolated elements such as the ability to classify or cross-classify at certain ages (Hazlitt, 1930; Thompson, 1941; Annett, 1959). Vinacke (1952) has reviewed these early works quite thoroughly. Relatively few psychologists have attempted to deal with the development of classification abilities as a part of an all-encompassing theory of intelligence. Among the exceptions are Guilford (1967), whose structure-of-intellect model includes classes and relations and Bruner al (1956), whose study of thinking deals at length with classes and the manner in which children utilize them to acquire concepts. Nevertheless, Inhelder and Piaget's works (1958, 1964) remain the two most authoratative and comprehensive treatments of the development of logical thought in children. Their theories and experiments have proven to be of such great interest to other researchers that much of the subsequent work in the area has been replications of their studies. Most of these, up to the early 1960's has been reviewed by Flavell (1963). However, since Inhelder and Piaget's book, The Early Growth of Logic in the Child did not appear in English until 1964, replications and extensions of this work have not been reported until recently.

Because Inhelder and Piaget's theory is so central to this particular research, it is important that Piaget's definition of class be clearly understood. There are four fundamental properties of classes. (1) No object can be a member of two classes simultaneously. That is, classes are mutually exclusive or disjoint. This does not imply that one cannot be included in a superordinate class. (2) All members of a class share some similarity, this communality being referred to as intension. (3) Each class may be described in terms of a list of its members. Such a list is the extension of the class. (4) The defining property of a class determines what objects are placed in it. That is, intension defines extension.

In their study of the growth of logical thinking, Inhelder and Piaget identified three stages of development. Stage I occurs during the ages of about 2 to 7 years and is characterized by the child's inability to classify objects correctly due to the following types of errors in reasoning. The child does not operate under a system of rules or an awareness of defining properties. For example, given a number of objects to classify, the child will make either small partial arrangements in which some, but not all, of the objects are related, or he will construct groups of complex objects which form interesting patterns or a picture. In any event, the collections are not true classes since intension does not define extension.

A child at Stage II (ages 5 to 7 years) produces collections which appear to be true classes, however, upon further investigation it is evident that the child does not understand class inclusion relations and the way in which elements within the class are related to the entire class. That is, the

Child can divide a whole into two sub-groupings, but he cannot think simultaneously of both the larger collection and the sub-divisions of it.

Children at Stage III (from 7 to 11 years of age) can construct hierarchical classifications and can comprehend class inclusion relations. However, the child can think only in terms of the concrete objects before him and cannot classify or understand class relations for imaginary elements. Hence, Piaget terms this third stage that of concrete operations.

Using logico-mathematical structures as models of the actual organization of cognitive structures, Piaget has devised nine groupings through which he explains the structure of classification and the understanding of relations. The following description of Grouping 1 has been substantially simplified. Those interested in a more formal account of the other groupings and their relation to logical thought development are advised to consult Piaget (1949), Flavell (1963) or a treatment of Piaget's application of formal logic and mathematics to psychology as described by Grize in Beth and Piaget (1966).

Grouping 1 serves as an illustration of the other eight "groupements" since it contains the basic characteristics of them all. Given a class of objects containing several elements and the binary operation of combining, the five properties of the goup may be identified as follows: The first property is composition (or closure in mathematics) meaning that when any two elements of the system are combined, the result will be another element within the system. This property underlies the child's ability to understand a hierarchy and to construct a larger class by combining its subclasses. The second property is that of associativity. A child who understands this operation will realize that he can combine classes in different ways or orders and arrive at equivalent results. For example, given the classes yellow roses (A), roses (B) and flowers (C), they can be combined in the following ways: $A + B = B$; $B + C = c$; $(A + B) + C = C$; $A + (B + C) = C$.

The third property is identity, the "nothing" element which when combined with the other elements in the system produces no change, Using the symbols from above, $A + 0 = A$.

The fourth property is negation or inverse which means that for any element in the class or sytem, there is another element (the inverse) which when combined with the first, produces the nothing element. Again using the previous symbols, $A + (-A) = 0$. This type of thinking involves the operation which Piaget has termed reversibility. Applied to classification problems, it is revealed in examples such as the following: yellow roses are combined with all other roses; if one takes away (inverse or negation) all of the other roses, one is left with the yellow roses. Applied to class inclusion problems, the reversibility operation works as follows: given roses (B), take away roses which are not yellow (A', the inverse of A) one is left with all roses which are not yellow.

This type of reasoning allows the child to comprehend that yellow roses are included in the class of roses and that the yellow roses are only some of the elements of the larger class.

The fifth property of the group is tautology which means that when the same action is repeated, it either adds nothing to itself or else is a new action with a cumulative effect. Hence, yellow roses (A) added to yellow roses (A) yields yellow roses (A). This can also be applied to class inclusion operations in which yellow roses are added to the superordinate class roses resulting in roses, A + B = B. The latter is termed resorption.

A second aspect of Inhelder and Piaget's theories and experiments of logical thinking deal with the growth of the child's ability to understand relations. This type of thinking is necessary for serial ordering and is explained in detail elsewhere (Inhelder and Piaget 1958, 1964). Very briefly, their studies indicate that a young child first learns to arrange objects by size at age 7, weights at about age 9 or 10 and that a ball changes its course as a result of its angle of firing. Later, he begins to understand correspondences between two series and is able, for example, to understand which mean goes with which end. Each of these stages is based on an understanding of the logic of classes and the logic of relations, however, the child up to the age of 11 or 12 can apply this type of thinking only to present realities, hence Piaget's term "concrete operation". During the stage of formal operations (from 11-12 years on) the child comes to control formal logic and to apply it to situations in which he must reason using propositions and hypotheses.

A fundamental difference between the approaches of Piaget and other researchers of the intellect such as Bruner should be noted here. While Piaget has attempted to discover how a child thinks, at what ages he is capable of certain kinds of thought and how this may be explained by a comprehensive psychological theory couched in mathematical-logical terms, others like Osgood (1953), Bruner, Goodnow and Austin (1956), Guilford (1967), Ausubel (1958), Gessell (1949) and Goss (1961) have usually selected isolated segments of logical thinking as reflected by specific experiments in object sorting, classifying or relational understandings and like Bruner et. al. (1966) have spent much of their efforts in attempts to determine how a child will think under controlled conditions, how he will attack certain problems, or to what criterial attributes he attends. While the results do contribute to the theories of intelligence, Piaget and his collaborators remain unique in their approach which has resulted in a theory which accounts for the interaction between maturation and experience in intellectual development and which has shown how childrens' thinking develops in sequential stages through a number of apparently invariant steps.

Studies relative to Piaget's theory

Many researchers have attempted to replicate, validate, extend or at least compare Piaget's findings with their own.

Ervin (1960) tested second and third grade children on their ability to discover the relations of four variables to the flexibility of rods. The method was a replication of Inhelder and Piaget's (1958) work with formal operational thought in adolescents. Ervin confirmed Inhelder and Piaget's theory and found that her subjects failed to control and vary factors so that they might test preditions and understand cause and effect relations.

Keats (1955) tested Piaget's thesis that concrete operations precede formal ones. Children from ages 9 to 15 were asked to solve problems in arithmetic, probability and inequalities. Two test forms were used, the difference being that one was couched in more abstract terms than its concrete operational counterpart. Despite some theoretical problems as identified by Flavell (1963), Keat's findings do substantiate Piaget's theory.

One of the most extensive studies of Inhelder and Piaget's theory of classification was undertaken by Kofsky (1966).

Kofsky derived a hierarchy of eleven sequential steps which were translated into experimental procedures and administered to a sample of children in attempt to determine whether the predicted sequencing of items would prove valid. The eleven classifactory skills were identified as:

1. resemblance sorting
2. consistent sorting
3. exhaustive sorting
4. conservation
5. multiple class membership
6. horizontal reclassification
7. hierarchical classification
8. "some" and "all" relations
9. "the whole is a sum of its parts"
10. conservation of hierarchy
11. inclusion

The administration of the items involved the manipulation of sets of geometric blocks in individual testing situations.

The subjects consisted of 122 children of above average intelligence, ten boys and ten girls at each age level between 4 to 9 inclusive.

The results of the study indicated a significant correlation between age and performance on the tests, age and the number of tasks mastered and age and the scaling of the test items themselves. However, while the predicted sequence of difficulty of items was found to be correct, there was no set order of mastery such that the passage of a more difficult item invariabl precluded the passage of all of the easier items. Hence, Kofsky concluded that individuals vary in the sequence of mastery of logical thinking tasks and the steps through which they attain perfection of any particular task. In interpreting this study, it must be kept in mind that Kofsky's samples at each grade level were quite small for the purposes of identifying invariance sequences and that her results may best serve to point out the problem of "horizontal decalage". The latter, according to Piaget, is the phenomenon in which a child may appear to be at one stage of mental development for a certain task or even when tested with certain materials, but may be at another level for what may appear to be a task requiring similar modes of thinking. A well-known example of this occurs with regard to conservation concepts where a child is able to conserve mass earlier than he can conserve weight.

Another comprehensive replication of Piaget's work was conducted by Lovell (1961). Two hundred average and bright subjects ranging in age from 8 to 32 years were tested on a number of experiments described by Inhelder and Piaget. Levell replicated 10 of the original 15 experiments and each S was tested with a random selectionof four of these. The tests used were: flexibility of rods, oscillation of a pendulum, falling bodies on an inclined plane, effects of invisible magnetism, combinations of colorless chemical bodies, conservation of motion on a horizontal plane, equilibrium in the hydralicpress, equilibrium in the balance, projection of shadows, and correlations.

In general, Lovell confirmed the major age-stage relationships identified by Inhelder and Piaget (1958) and it was noted that the least able subjects remained at a low level of logical thought even past the age of 15.

Lovell, Mitchell and Everett, (1962) further tested the relevance of Piaget's theory as applied to classification, seriation, multiple relationships, hierarchical classifications and "all-some" relationships in class inclusion problems. Using a battery of eight tests with normal and subnormal children from ages 5 to 15, the authors found grounds for agreement with the Piagetian theory plus the fact that the development of subnormal subjects lags considerably behind that of normal children.

Dowell (1962) also used a battery of Piagetian type tests to assess childrens' abilities to classify and to understand cardinal number. Dodwell compared his results with those of Piaget and Inhelder and found them to be quite similar with the exception of some age differences.

Similar results are reported by Jackson (1965) who tested the growth of logical thinking in normal and subnormal children. Using six of Inhelder and Piaget's (1958) tests, Jackson evolved a "sum of logical thinking" score which he compared with chronological age and scores on Raven's Porgesssive Matrices. Each of the correlations was highly significant and Jackson concluded that while the responses generally followed the Inhelder-Piaget levels of logical thought development, there was a wide variation in the level of ability of children at the same age. He also found that the ability to think logically at one level does not imply the ability to think at that level in other situations. These findings agree with those of Dowell (1962) and Kofsky (1966) who also found variations in age-stage relationships. However, as pointed out earlier, these variations may be attributable to individual differences over the same level of logical thought development or what Piaget terms "horizontal decolage".

A complex study of logical thinking in terms of childrens' abilities to understand logical multiplication was devised by Shantz (1967) who investigated the combination of two elements of multiplication of classes, two asymetrical logical relations, (longer and darker) and two asymetric spatial relations (above and to left of). Multiplication of classes was assessed by Raven's Progressive Matrices, asymetric logical relations by a specially constructed multiple relations test of partially constructed matrices and the multiplication of spatial relations by a modified version of Piaget's landscape test in which subjects were asked to locate figures in relationship to their placement on a similar landscape. Seriation pretests were given to familiarize subjects with dimensions and ordering values. Subjects were 72 children of average IQ at 3 age levels, 7½, 9½, and 11½, equally divided between boys and girls, 24 subjects at each age level.

Shantz hypothesized that there would be a high correlation among the three multiplicative tasks within each age level. Results indicated a singificant association among the test for the 7½ and 9½ year olds. However, the oldest group, (11½ year olds) performed at levels which were not significantly related ($P = .10$). All three multiplicative abilities improved with age in an almost linear trend.

Wei (1966) also used test items from Inhelder and Piaget to assess four classification abilities with primary school children. His findings support the contention that classification abilities develop sequentially and with increases in chronological age.

Bruner and Kenney (1966) report a study, which, while it was not designed to replicate Inhelder and Piaget's work, does serve to add credence to their theory. Bruner and Kenney's investigation concerned the child's ability to understand double or multiple classifications as evidenced by their ability to reproduce or transpose a three dimensional matrix. Using subjects from the ages of 3 to 7, the authors identified several levels of development in the ability, levels which appear to closely resemble those of Inhelder and Piaget. However, as noted earlier, Bruner's approach emphasizes the aspects of logical thinking which lead to the mastery of the specific test under consideration and he does not deal with the manner in which a child progresses from one stage of development to another. Another point of departure from Piaget is that Bruner relies heavily on the role of language to explain how a child can cope with classification problems. This is contrary to Piaget who asserts that language merely accelerates the development of notions of classes, relations and series, but that the development of these operations is largely independent of language. This contention is supported by Reichard et al (1944) who found that young children develop the ability to classify elements into classes before they develop the language proficiency which allows them to explain verbally how or why they grouped as they did.

Further clarification of the role of language to the ability to classify is offered by Furth and Youniss (1965) who administered test of two kinds of logical thought (one of discovery and one of application of logical rules) to deaf subjects and to subjects who were deficient in language abilities. The results of the investigation led the authors to conclude that the development of logical thinking cannot be critically dependent upon the presence of language since the deaf subjects who were severely deficient in language performed as well as a control group of hearing subjects who had a normal language proficiency.

An usual approach to logical thought was taken by Gardner (1966) who studied the understanding of the logical operators in propositional reasoning. An examination of his data over grade levels led Gardiner to conclude that the results were consant with what Piaget might have predicted for the development of logical thought.

A recent study by Ennis (1970) investigated the relationship of the growth of elements of conditional logic in primary school subjects. These elements were defined to be those of contraposition, conversion, inversion and transitivity. The instrument used to measure development in these areas was a series of verbal questions which required the subject to think through a set of relationships exemplary of one of the four conditions being tested. Although an attempt to teach formal logic to the subjects failed, and the reported results are based on the performance of the control subjects, Ennis claims that his findings indicate that many of the primary grade subjects have mastered some of the basic principles of conditional logic. Ennis argues that since conditional logic is fundamental to propositional logic, his findings refute Inhelder and Piaget's (1958) claim that children under the age of 11 or 12 cannot handle propositional logic.

In view of the author's failure to teach conditional logic to children of the same age and the problem of accurately assessing what was being measured by the tests he devised, a more accurate interpretation of the findings might be that this is another case in point where children are able to handle parts of some logical operation under a given set of circumstances but can do so neither repeatedly nor in cumulative stages, which would prove their ability to think in terms of conditional logic, an ability which requires both abstract thought and the use of hypothetical reasoning.

Other Studies of Logical Thinking

Many other approaches to logical thought have been utilized by researchers who have not relied on the Inhelder-Piaget theory of logical thought development. Several of these are investigations of rather isolated segments of childrens' abilities, however, they do serve collectively to shed additional light on the growth of logical operations.

Hill (1961) administered a 100 item test of logical thinking to 6, 7, and 8 year old children. The test contained items dealing with formal logic in the form of syllogisms, simple and compound tautological implications etc. The results indicated that young children can recognize the validity of logical inferences, that this ability increases with chronological age, and that progress is not in fixed stages but takes the form of a gradual steady growth. There were no significant differences in the childrens' abilities regardless of whether the test was administered orally or in written form and the addition of negation items significantly increased the difficulty of recognizing validity.

Another study of childrens' abilities to deal with formal logic in the form of syllogisms was conducted by Shapiro and O'Brien (1970) who adapted parts of Hill's (1961) test so that some items were "open" in that the second premise was stated in the negative and the subject was asked to judge the validity of the conclusion. A paper and pencil form of this test was administered to children of ages 9 to 17. Contrary to Hill's findings, the authors found that the youngest children performed very poorly on the "open" items and responded in a "child logic" in which they interpreted "if--then" to mean "if and only if--then".

A syllogistic type test was also used by Miller (1968) who administered a test of logical inference patterns to secondary school students (ages 14 to 18). He reported that the majority of subjects in all grades had trouble differentiating between valid and invalid inferences and that performance on the test was related to intelligence and increased grade levels. Hence his findings tend to refute Hill's as do those of Shapiro and O'Brien.

A great many studies have used object sorting tasks as measures of subjects' classificatory development (Heald and Marzolf 1953; Sigel, 1953, 1954; Goldman and Levine, 1963; Furth and Youniss, 1965; Johnson and O'Reilley, 1964; Kosfky and Osler, 1968, Wohlwill, 1968; Earhart, 1970; Boger, 1970; and Melcer, 1970.) All of these have revealed a decrease in the use of perceptual or concrete categories and an increase in the use of nominal or designative categories with an increase in age. In fact the utilization of concrete, functional and designative concepts in multiple classification was the subject of a study by Parker and Halbrook (1969) in which they presented primary school pupils with matrices comprised of various combinations of these three types of concept exemplars. Their results supported the previous findings that performance increases with age and grade level and that the ability to understand multiple classification depends upon the type of concept utilized in the test item. The order of difficulty these researchers established was, as predicted, concrete concepts preceding functional concepts with the use of designative concepts appearing last.

Other researchers have devoted their attention to the problem of attribute preference in classification problems. Goldman and Levine (1963) using the Goldstein-Scheerer Object Sorting Test, found that very young children prefer to sort first by color, then by shape and lastly according to the designative concept or class name for the elements Progression through this sequence was related to an increase in chronological age. Heald and Marzolf (1953) also found that young children prefer color as a sorting attribute and that the ability to shift categories to form another class using the same elements was a more difficult task especially for the youngest subjects. Kofsky and Osler (1967) also found color to be the most favored characteristic, followed by form and the size. Yudin (1966) on the other hand, found concepts of number significantly more difficult to attain than either color or form and reported that there was no significant difference in the rate of attainment for the latter two.

Huttenlocher (1964) investigated the effect of sequences of positive and negative instances of concept attributes on childrens' attainment of class concepts. He found that a positive instance followed by a negative instance led subjects to the criterial attributes the fastest, while two negative instances of the attribute proved to be the hardest for children. He concluded that irrelevant attributes cannot be handled as early as a direct demonstration of the attribute for which the subject is searching. This would seem to be in keeping with Inhelder and Piaget's theory that the ability to understand and to apply the inverse or negation element of grouping is one of the last abilities to develop.

Possibly due to the relative lack of attention which has been paid to the problem of the development of logical thinking, few studies have been conducted concerning the question of whether children who cannot think logically can be taught how to do so, or whether they can transfer their logical thinking abilities to other related problems. A study pertaining especially to the latter was conducted by Ervin (1960) who tested a group of third and fourth grade children on their ability to transfer logical abilities from one task to another. Only half the subjects were able to transfer to the second task. This was interpreted as indicating that although the tasks required similar capabilities, the children saw them as being different. Ervin concluded that success on various transfer tasks was related to spatial and verbal abilities and suggested that maturational aspects may be the crucial variable.

Nowak (1969) studied the ability of third grade children to classify after receiving instruction in the processes. She found that instruction did lead to better performance and that training on both simple and hierarchical classification tasks was more beneficial than training on the latter alone. Ennis (1970) trained first, second and third grade children on syllogistic type problems involving contraposition, conversion, inversion and transitivity. Results indicated that the training had no effect on the childrens' abilities to understand conditional logic. Contrary to Ennis' suggestions, these findings tend to support Piaget's theory since the application of conditional logic requires abstract thinking, an ability which appears after the stage of concrete thought which ends at approximately 11 years of age.

A more successful transfer of training study is reported by Jacobs and Vandeventer (1968). A pretest was given to identify subjects who scored highest on a test of double-classification. These S's were then assigned to experimental or control groups. Experimental subjects were given pretraining in solving double-classification problems with stimuli varying in color and shape by the use of a 2 x 2 or 3 x 3 matrix task. Control subjects were engaged in an irrelevant task. In the training task, subjects were required to fill in an empty cell on the basis of form and color.

To assess transfer, an eight-item test was constructed using a matrix involving size and shading (dots, stripes, etc). A second transfer test involving parts of Raven's colored progressive matrices was also used. The transfer tests were given immediately after training, and 4 months later. Subjects were 42 boys and girls divided randomly into experimental and control.

On first transfer test, the experimental group showed significantly more learning than the control group. On the second transfer test, the experimental group again performed significantly better than the control groups.

No significant changes occurred with regard to performance on Raven's Progressive Matrices. Which was administered at the time of both transfer of training tests. This is an especially troubling results since Raven's Progressive matrices have consistently correlated highly with other tests of classification.

Another successful training study is reported by Edwards (1969) who instructed first grade boys on object matching. Those receiving training were found to perform better than a control group and Edwards concluded that childrens' categorizing skills can be modified on a group instructional basis. Successful transfer of training was also obtained by Johnson and O'Reilly (1964) who trained 11 to 12 year olds on classification tasks and on tasks which required the subjects to define their classifications. The results indicated that the group with defining practice gave significantly more acceptable definitions of their classes than a control group and that success on a transfer classification task was related to success in defining.

A major study of classification training effects is reported by Melcer (1970), Bogner (1970) and Earhart (1970) all of whom deal with the same topic, that of training head start children in classification tasks. According to their results, these children can and do learn the operations they are taught, but they cannot transfer or generalize these acquired abilities to other theoretically related areas of cognitive activity.

A small body of literature pertains to the relative efficacy of classification questions presented in pictorial versus verbal form. Sigel (1954) developed five classification tests in which the subject was required to sort the materials on the basis of similarity. The test materials consisted of objects which were manipulated, not manipulated, photographs of the objects, cards containing the names of the objects and a sheet of paper on which all of the objects were listed. The subjects in the experiment were children from three age levels: 7, 9 and 11. The results of the study showed that regardless of the stimulus presentation of the item, the subjects tended to respond in a similar fashion. These results were obtained regardless of the degree of manipulation involved as well and it did not matter whether the grouping was on the basis of perceptual or conceptual classifications. Sigel suggests that children tend to classify on the basis of the "meaning" (function) of the objects rather than on the basis of the physical properties of the object itself.

Results of an opposite nature are reported by Wohlwill (1968) who conducted a series of studies comparing childrens' responses to classification questions when the items were presented in pictorial as opposed to purely verbal forms. With children between the ages of 5 and 7 there was a consistent, highly significant superiority of the verbal condition over the picturial one, a finding which Wohlwill attributes to the weakening of a sub-class comparison set ingendered by the perception of the majority and minority subclasses in the pictorial condition. However, he also adds that factors of a more instrinsic nature relating to the level of cognitive development attained by the child codetermine performance on these tasks.

Apparently, the question of the most beneficial manner in which to present classification tests is still unsolved. It is worthy of note, however, that many of the testing materials used to measure the classification abilities of young subjects has been of a pictorial nature. These have been of both the paper and pencil variety as well as incorporated into film and slide presentations.

The relation of logical thinking to race

Several studies have been conducted in which the relationship of race or cultural background has been related to the growth of logical thought, the latter usually being tested through an application of some kind of Piagetian type test. Zimiles and Asch (1969), Goodnow (1962), Goodnow and Bethon (1966) and Greenfield (1966) report that it makes little difference whether the subjects live in Mexico, Senegal, Anchorage, Aden or Africa, the sequence found in the development of abstract conceptualization and logical thought adheres to the invariant stages identified by Inhelder and Piaget (1958). However, there is a marked and important difference in the age-stage relationships, generally with the result that subjects of culturally deprived or minority races lag behind in the development of some logical thought processes. De Lacey (1970) conducted a study of the classification abilities of high-socioeconomic (SES) Europeans, low-SES Europeans and two Aboriginal populations differing in the extent of their contact with Europeans and their culture. Four classification tests were administered: a test of "some-all" relations, a test of hierarchical classification, a test of multiple classification and a reclassification test which required the subjects to sort and then to resort using different criteria. The results showed a consistent relationship between milieu and the classification abilities of the subjects. On all four tests, the order of performance was: high SES Europeans, low SES Europeans, high-contact Aboriginies and low-contact Aboriginies. The amount of lag is not reported.

Purl (1967) reports a similar finding with regard to the development of concrete logical thought (the stage at which classificatory abilities develop) in Mexican and Negro subjects compared to Anglo-American subjects. Okonji (1970) studying the classificatory behavior of Nigerian children on sorting tasks to similar conclusions. He concluded that the ability to perform logical operations can be accelerated or retarded as a function of cultural and educational conditions. Scott (1969) tested seriation abilities, (abilities which precede classification skills) among Negro and white subjects at the kindergarten level. He found a wide variation in scores between race but a narrow difference within race.

Price-Williams (1962) tested bush children in Nigeria on their ability to employ abstract and concrete modes of classification. Despite the fact that some of the subjects were attending school and others were essentially illiterate, no differences were found in their abilities on classification tasks. Price-Williams interprets this as indicative of the fact that Piaget's invariant sequence of levels of logical thinking holds true, however, the data indicate that there is a lag in this development for these subjects in comparison with the performance of European subjects.

Deutsch (1965) also reports minority differences on a battery of tests including subtests [illegible], of classification. He found that Negro children and lower class white subjects were victims of a "cumulative deficit phenomenon" in which their verbal and logical thinking abilities deteriorated as the child moved from first to fifth grade.

Hence it would appear from these studies, that while Inhelder and Piaget's sequence of stages of logical thought may hold true within various cultures, cultural deprivation and/or membership in a minority group often results in a lag in the growth of logical thought as compared to its development among more advantaged subjects.

Socioeconomic differences and logical thought

Low intelligence as measured by traditional intelligence tests has often been found to be associated with unstimulating environments. Children from such environments are sometimes described as culturally deprived or disadvantaged and are typically exposed to a restricted range of experiences resulting in a less systematic ordering of these experiences and their thoughts concerning them (Deutsch, 1963, 1965). They consequently evidence low verbal intelligence (Eels, 1959), low school achievement (Choppin, 1967), a restricted vocabulary (Schulman and Havighurst, 1947) and a defective comprehension of graphical representations of objects and events (Sigel and McBane, 1967). A similar finding pertains to their performance on measures of logical thinking. Almy, Chittenden and Miller (1967) investigated Piaget's stages of development by means of cross-sectional and longitudinal methods. In each case the sequence of invariant stages was substantiated, but middle class subjects performed at higher levels than lower class subjects.

Wei (1967) studied advantaged and disadvantaged Ss at the K and second grade levels on classification tasks and found culturally deprived children progressed at a slower pace than the culturally advantaged. Two years of schooling for the deprived group brought them into closer correspondence with the middle class group. A difference was found between the low and middle class groups in reasoning processes. The deprived groups were not as clear in their explanations and there was significantly different justification scores between the two SES levels.

Hooper (1969) studied the intellectual development of Appalachian children classes as culturally deprived. A battery of standardized tests and Piagetian tasks were administed. Hooper concluded that in certain cases deficits appear to increase in severity as the disadvantaged child gets older, thus indicating the pressing need for intervention at the earliest feasible age level. In addition, Piagetian logical operations skills appeared to be significantly inferior as compared to middle-class performances at least for first-grade children.

Teets (1968) compared low and middle class of the Appalachian region on performance of Piagetian tasks and found that even after the IQ effects were partialed out, sizable correlations remained between SES and task performance.

Similar findings pertaining to the deleterious effects of lower SES have been reported by Glassman (1969), Lovell (1961), Purl (1967), Deutsch (1965), Furth and Youniss (1965) and Nelson (1968). Shapiro and O'Brien (1970) found SES to be a factor in the retention of "child logic" patterns among adolescents and reported that while middle class subjects rely on more mathematical models of logic thought as chronological age increases, lower class subjects actually tend toward an increase in the less accurate "child" logic. Ennis (1970) also found SES related to logical thinking. According to his findings, primary subjects' performance on measures of logical thinking was associated with their living area as well, with surburban subjects performing at the highest level. Sigel and McBane (1967) reported that lower class subjects not only perform at a lower level on tests of logical thinking, but that their entire development appears to be slowed such that their attribute preferences also lag behind those of middle or upper class sugjects. Thus, the evidence seems to point quite conclusively to the fact that socioeconomic status differences can and do effect the growth of logical thinking.

Logical thought development and intelligence

The relationship between the development of logical thinking abilities and standardized intelligence tests is not completely clear at this time. Piaget's view is that logical thinking is a necessary condition for intelligent thought and that its full development at the age of formal operations when a child can think abstractly in propositional or hypothetical terms, marks the high point in intellectual capabilities. However, it would seem that while tests of logical thinking measure some aspect of intelligence, they do not measure the same factors as the standard intelligence test. Niemark and Lewis (1967), for example, found that mental age rather than IQ score was a more significant factor in the growth of logical thinking. Similarly, Yudin (1966) did not find a significant relationship between traditional measures of intelligence and the ability to think logically. Rather, he suggest that there is an interaction between chronological age and intelligence which may account more readily for development in this area.

Logical thinking and conservation

The link between conservation and the ability to engage in logical thinking is well established by Piaget and those who have replicated his studies. Addressing himself to this topic, Piaget (1952 p. 19-20) states

> ...logical multiplication of relationships are essential to the child's solution... It is not, therefore, the discovery of conservation which makes possible the multiplication of relations, but the contrary.

Just as the ability to conserve is dependent upon the logical thinking ability reflected in the multiplication of relations, so too, is the concept of number dependent upon an accurate knowledge of seriation and classification. Very few studies have attempted to explore these relationships. One of the latter is reported by Wohlwill (1968) who concluded from his investigations that the ability to handle class inclusion problems consistently precedes the acquisition of conservation. The relationship of class composition and additive classes to the concept of cardinal number was measured by Dodwell (1962) who, while he could not conclusively prove the relationship, suggest that these two sets of concepts are related and that they definitely develop at the same age. Darnell (1969) examined training on multiple classification and relations and found that this led to an improvement of performance on conservation problems. Similarly, Almy, Chittenden and Miller (1966 p 13) state that

> The child's ability to comprehend the principle of conservation as it applies to matter and quantity is...a landmark in the development of logical thinking.

Thus it may be seen that any test of conservation involves a measure of logical thinking and visa versa.

Logical thinking and educational achievement

Several studies have been conducted which prove the relationship of tests of logical thinking to certain areas of school achievement. One of the best of these is that of Almy, Chittenden and Miller (1966) who in both a logitudinal study over a two year period and in a cross-sectional study found that children who performed well on tests of conservation (which include measure of logical thinking) also do well in standardized tests of reading and arithmetic. Similarly, Scott (1969) used a seriation test with kindergarten children and found a significant correlation with performance on the former and achievement in reading and number readiness. These findings agree with those of Braun (1963) who showed that the ability to formulate concepts as measured by the ability to abstract common class attributes was related to reading achievement for elementary school pupils. Nelson (1969) also used a seriation test at the kindergarten level and was able to use this measure to predict academic achievement accurately in selected subjects for up to a two year period. A study by Freyberg (1966) also linked concept development in Piagetian terms to school achievement. He concluded that the latter is closely associated with aspects of conceptual growth that are not adequately assessed by convential intelligence tests. These studies together with those of Boger (1970), Iijima (1966) and

Berglund (1963) point to a strong, if not well defined, link between Piagetian type measures of logical thinking and the prediction of school achievement, probably in a way or ways not presently measured by the usual intelligence tests.

Operations to be measured

Since the specific behaviors to be measured are spelled out in detail in the sections pertaining to the rationale and description of the instruments to be used, they will be dealt with very briefly in this section. It is quite clear that the literature points to the need for the development of an instrument or instruments which will assess childrens' abilities to understand seriation and to apply it and its concomitant knowledge of serial relations to problem solving situations. In addition, such an instrument will be expected to measure classification abilities as revealed through the solution of classification problems, class inclusion, the selection and identification of criterial attributes, the ability to handle the addition and multiplication of classes and to do so with and increasing number of attributes to be considered simultaneously. Measures will be devised for both the concrete and the abstract levels of thought. With regard to the latter, such instruments will deal with propositional inferential and hypothetical thought patterns.

Problem Solving

I. Psychological Models

The psychology of human PS has been an area with a great many contributors but few authorities. Early reviews of the field pointed out the lack of unity in methods, tasks, and theories used in PS research (Duncan, 1959). Classical models of Dewey (1910) and Wallas (1926) described PS behavior accurately, but did not explain it. Association theorists proposed a precise explanatory model of PS, but were accused by Gestaltists, such as Wertheimer (1959), of being too mechanistic and too inflexible. PS should be considered a truly creative and productive act, but the Gestalt models were difficult to define operationally, and so resulted in little in the way of strong research.

Modern theorists, such as Gagne (1970), Ausubel (1968), and Guilford (1967), however, have adopted the Gestalt view of productive PS and have generated several useful models of the processes and abilities involved. Gagne's rule-learning, Ausubel's "subsuming" structure, and Guilford's "structure-of-the intellect" model have focussed attention on the individual's generation of new information during PS.

Theorists concerned with instruction have contended that the transfer of broad, generalizable behavior, not specific skills, should be the major goal of instruction in PS (DeCecco, 1968; Klausmeier and Ripple, 1970). The individual will not be able to produce new rules or relationships without the ability to solve large classes of problems. Thus, the assessment of PS behaviors must sample a broad range of skills within given types of problems.

Reviews of PS

Duncan (1959) reviewed a considerable amount of research in human PS. He concluded that no great studies would be made in such a diverse field until some sort of theory development accompanied experimentation. Too many different kinds of tasks had been used to measure PS abilities and leaders of research efforts had failed to generate an agreed-upon taxonomy of the behavioral processes involved in PS.

Later, Davis (1967), in his review, attacked both of these problems. He described three theories of PS behavior and also offered a unifying model of his own. Association, cognitive, and mathematical learning theories all had interpreted the problem situation and PS behaviors in different ways. Davis, however, generated a classification of tasks which focussed on the actual behavior elicited during problem solution.

He proposed two types of PS: overt and covert. In a problem situation the individual is usually confronted with a series of alternative courses of action. If the individual does not possess knowledge of the outcomes of these alternatives, he must overtly test some of these alternatives to determine which may or may not be useful. On the other hand, if the individual already knows the outcomes of many of the alternatives he can covertly test these alternatives with respect to the whole problem solution.

Anagram problems, water-jar and arithmetic problems, and "insight" problems, such as Maier's "two-string" or "hatrack" problems, are typical Type C tasks because their solutions are, to such a great degree, a function of past experience. An individual's ability to solve anagrams, for example, depends upon his knowledge of the language, its rules of usage and grammar. Thus, when the individual faces an anagram problem, he has a knowledge of highly probable or improbable rearrangements of the letters and his work is considerably reduced.

Switch-light problems, probability learning, and classification tasks are representative of Type-O PS. With these tasks, the individual must first discover which responses are reinforced and which are not. For example, in probability problems the individual must adopt a strategy of choices which maximizes reinforcement. If the individual is faced with three or four alternatives, he must first test each one, on a trial and error basis, to discover their respective "pay-off" rates.

Davis' overt and covert PS behaviors emphasized the amount of experience available to the individual. Before problem solution could be attempted, necessary prerequisite testing of alternative responses had to be done. His model therefore, depended upon trial-and-error behaviors. Getzels (1964), however, proposed a model of the problem situation. The first step of the "scientific method" has always been to define the problem and its parts clearly. Past experience is certainly an important factor, but the individual must first understand, or define the problem. Getzels thus made the distinction between given, or stated problems, for which Davis' trial-and-error testing would certainly apply, and problem situations for which the problem, itself, is not clearly stated or needs to be reformulated into a more workable form. He distinguished eight types of problem situations:

1. The problem is given (is known) and there is a standard method for solving it, known to the problem-solver (student, experimental subject) and to others (teacher, experimenter) and guaranteeing a solution in a finite number of steps.

2. The problem is given (is known) but no standard method for solving it is known to the problem-solver, although known to the others.

3. The problem is given (is known) but no standard method for solving it is known to the problem-solver or to the others.

4. The problem itself exists but remains to be identified or discovered (become known) by the problem-solver, although known to the others.

5. The problem itself exists but remains to be identified or discovered (become known) by the problem-solver and by the others.

6. The problem itself exists but remains to be identified or discovered (as in 4 and 5) and there is a standard for solving it, once the problem is discovered, known to the problem-solver and to the others (as in 1).

7. The problem itself exists but remains to be identified or discovered, and no standard method for solving it is known to the problem-solver, although known to the others (as in 2).

8. The problem itself exists but remains to be identified or discovered, and no standard method for solving it is known to the problem-solver or to the others (as in 3).

Davis' and Getzels' models stressed different aspects of the PS process, but together they reflected, in a more practical and useable way, the classical viewpoints of human PS. Loree (1970) reviewed John Dewey's (1910) logical steps to problem solution and Wallas' (1926) sequence of creative production. Dewey proposed that PS involved: (1) the sensing of a difficulty, (2) the locating or defining of the difficulty (Getzels), (3) the suggestion of possible solutions, (4) the consideration of their consequences (Davis), and (5) the acceptance of a solution. Wallas combined several of these stages and suggested a preparation, or information-gathering, phase (cf. Getzels and Davis), an incubation phase (unconscious work going on; cf. Davis), an illumination phase (solutions emerge), and a verification phase (solutions are tested and elaborated; cf. Davis).

These older models treated PS from a very molar point of view. To be sure, they described several stages of PS, but each stage or phase represented whole classes of behavior, such as defining the problem and its parts, or the suggestion of various possible solutions. These models described very well the appearance of PS in individuals, but provided little specific direction for experimenters interested in identifying and changing the wide variety of independent variables affecting PS.

Association Theories of PS

Staats and Staats (1963) proposed a model of PS within the context of S-R, or association, theory. They hypothesized that the individual undoubtedly makes many different responses to the same stimulus situation. These responses, however, are usually quite differentially reinforced. Eventually one or two responses become more strongly associated with the particular stimulus and are exhibited more often, but, in fact, an entire hierarchy of responses develops within the individual on the basis of the strengths of associations between stimuli and responses.

When confronted with a problem, the individual will draw upon past experience and this hierarchy of responses. If the most probable, or strongest response associated with S (the problem situation), will lead to the correct solution, it will be emitted first and the problem will be solved quickly. On the other hand if the correct response is only remotely associated with S (i.e. is low on the hierarchy) more trial-and-error testing of alternatives will be necessary and the problem will be considerably more difficult.

A model of response hierarchies does indeed provide an ideal operational definition of previous experience as an independent variable for researchers in PS, but also remains considerably limited in terms of its flexibility. Kendler and Kendler (1962), in addition to Staats and Staats, proposed a verbal mediational mechanism to facilitate the individual's "switching" from one response to another. Kendler and Kendler hypothesized two processes operating simultaneously during PS: A horizontal process of chaining several S-R associations and a vertical one consisting of several on-going parallel chains. Each stimulus gives rise to implicit verbal responses which, in turn, act as stimuli for pulling parts of both the horizontal and vertical chains together, thus providing the individual with a greater range of responses.

Association theories have also been used by authors interested in simulating human PS behavior with the aid of the computer. Newell, Shaw, and Simon (1958) developed an information-processing model of PS and a program which they called Logic Theorist. The program analyzed problem situations into its component parts (the stimuli), then built relationships between the parts of the problem and a library of response alternatives (S-R chains), then tested these relationships against a criterion and, if necessary, repeated the whole process again until the correct solution was achieved.

The information-processing model of PS resembled the classical models quite closely. Newell, Shaw, and Simon pointed out that such complex phenomena as set, insight (forever a problem of definition), conceptualization, or the building of hierarchies and rules could all be simulated within the structures of the Logic Theorist. Unfortunately, computer models are, as their associational forebears, inherently rigid. As Hunt (1968) pointed out, only a limited range of decision mechanisms are available to the computer, and while individuals highly trained in specific problems may follow a somewhat linear, computer-like, step-wise procedure toward problem solution, a variety of procedures may also be available to individuals which "are not analogous to a set of linear steps."

The Gestalt Model of PS

Hunt concluded that research in computer simulation has not gone far enough in terms of paralleling human PS processes. He suggested that researchers should study the cognitive processes involved in such games as chess and checkers and in "real-life" games. Gestalt and cognitive models had long stressed the inadequacy of the traditional theories of human thought. Wertheimer (1959) had dismissed the logical and associative models of PS because they simply did not characterize truly productive thinking in the individual. He argued that, breaking behavior into logical steps and S-R connections, the traditional viewpoints reduced human thought to a series of piecemeal operations. A more wholistic view was needed, one which described thinking as a genuinely creative process.

When faced with a problem the individual considers not only the problem parts but also the rules or relationships between the parts so that he can restructure the problem in new ways. Thus, a gestalt model reflects, to a great extent, Dewey's first stages of PS and Getzel's different types of problem situations. It is simply not enough that one analyze behavior, especially the thought processes, in a undirectional fashion, i.e. from whole to part. It is, in fact, man's nature, as Wertheimer, suggested, to operate in the other direction and generate, not just a whole structure, but an objectively better or more adequate structure.

Modern Cognitive Views of PS

Ausubel (1968) and Gagne (1970) have also adopted this dynamic view of thinking and PS. For Ausubel, the individual's task is to build a complex cognitive structure from previous experience. Problems may be solved quite easily if they can be "subsumed" into the existing structure readily. If not, the structure must be changed to accomodate new information and problem solution becomes more difficult.

Gagne on the other hand, views PS as the highest of eight categories of behavior: signal learning, stimulus response learning, chaining, verbal association, discrimination learning, concept learning, rule learning, and PS. Each of the seven lower levels is necessary in PS, for the individual must generate new knowledge and new rules in problem solution. Gagne does break behavior into parts and does include S-R association learning in his model, but his hierarchy is also reversible and can be used to produce new principles and relationships.

Guilford's Structure of The Intellect Model

Guilford's (1967) "structure of the intellect" model must be considered the most comprehensive and unifying model of PS to date, however. Guilford describes thinking along three dimensions: content, operations, and products. Each of these categories, in turn, consists of more specific categories focussing on the nature of the information available to the individual, what kinds of things the individual can do with the information, and what possible products can result from his manipulations.

All in all, over 120 distinct abilities have been hypothesized to make up the whole of intelligence and thinking. Production abilities occupy only two-fifths of the model but Guilford has distinguished two types of production, convergent production and divergent production. Both classes of behavior require the individual in a problem situation to generate new information, but convergent production tasks are structured so that the individual has but a few choices to make. His product can be evaluated on the basis of some widely agreed-upon criterion and judged right or wrong. Tests developed by Guilford to measure convergent production typically require the individual to draw "logic tight," unique deductions from given information. There is little freedom and the individual must adhere to a prescribed structure.

Divergent production, in contrast to convergent production, represents the processes of induction and the generation of possibilities, not necessities, from given information. Divergent production tasks call for flexibility and a variety of responses. Questions designed to measure divergent production are therefore, "open-ended" in nature. Considerably more freedom exists for the individual to manipulate the given information and his responses typically are evaluated on the basis of a continuum of quality, and not as right or wrong.

Transfer in PS

Divergent production is also the area in which the transfer of past experience is likely to play its largest role. Certainly the individual must be capable of transferring specific methods or techniques from one situation to another in the case of convergent production. He must understand, for example, what conclusions may logically be drawn from certain given sets of information. In divergent production, however, there are fewer restrictions, and, in fact, part of the task for the individual may be to establish his own "ground rules" or restructure or redefine the problem for himself (Getzels). For this, a much greater variety of experiences are needed and must be brought into play. In essence, the individual must call upon all of his resources and past learnings, regardless of specific categories.

DeCecco (1968) and Klausmeier and Ripple (1970) consider transfer to be, in fact, the ultimate goal of any kind of instruction in PS. DeCecco states that two types of behaviors are acquired during PS: specific solutions, applicable only to the single situation immediately confronting the individual, and general methods or solutions for classes of problems. General solutions usually develop after experience with a great number and variety of tasks, but it is these general solutions that hold the greated potential for growth and learning. They represent exactly genuine creative productivity in the individual.

These general solutions form Ausubel's "subsuming concepts," Gagne's higher order rule learnings, and Wertheimer's generation of more adequate structures. They represent, in effect, the very nature of cumulative learning and intellectual ability. Thus, if one is to obtain a reliable assessment of PS ability in the individual, a great range of behaviors must be measured within each problem-type. A test of problem-solving ability must make use of specific tasks for the items, but the tasks must nevertheless be selected to represent classes of problem-solving skill.

II. Processes

While the review and discussion of psychological models of problem solving has often focussed on steps, stages or elements of PS, most of the review of models is based on speculative or theoretical analyses of PS behavior. Often times these speculations result in elegant delineations of the PS process which may have more logical than psychological validity. It seems likely that the human problem solver in particular may often proceed in a far less logical, more eclectic and seemingly disorganized fashion than these models imply. Of course it should be acknowledged that a number of the models such as Guilford's and Gagne's are the result of extensive research programs. Thus, it would be unfair to assert that the models are entirely theoretical or speculative.

The present section of this report, however, turns specifically to analysis or description of psychological processes or elements of PS which have been identified or delineated in empirical research. As with the review and discussion of the models in part one, we assume that careful attention to the psychological processes involved in PS will yield insights which will in turn prove valuable in designing new PS tasks for this project.

Eight types or classes of process variables will be reviewed and discussed: (1) language, (2) complexity, (3) strategies and patterns, (4) factor analytic and creativity variables, (5) memory, (6) meaningfulness and principles, (7) rigidity and set and (8) prior knowledge. Specifically the review asks the question "How do the variables in each of these classes enter into or affect PS behavior?"

Language

The first class of variables involve language factors. Essentially the studies reviewed in this area investigated labelling or verbal mediation in PS. Ranken and associates have completed a series of studies on the effect of labelling of jigsaw puzzle parts on a subsequent problem in which Ss have to fit different puzzle parts together from a mental image (named or unnamed). In a study reported in 1963 he found that subjects who had not learned names for puzzle parts made fewer errors than those who had learned names. In a later study (Ranken and Dowling, 1965) they found that use of relevant labels which were meaningfully associated with the contours of the puzzle pieces enhanced problem solution whether the puzzles were presented concretely or symbolically. In the first study there was no relevant association between the puzzle pieces and the labels. In another study (Ranken and Wang, 1965), using in addition labels which suggested the shape of the piece, they found that contour labels facilitated problem solving but labels which merely suggested the shape of the piece resulted in no facilitation of performance.

Kendler, Kendler and Carrick (1966) studied the effects of verbal labels which were associated with several parts or stages of three problems upon performance on a fourth problem which depended upon solutions from the first three problems. The labels were designed to be the same or different from problem to problem in the sequence of four. They found that third graders were generally able to solve more problems than kindergartners. However, kindergartners profited more than third graders from the use of the same as opposed to different labels among the problems.

Cofer (1957) reviewed a number of studies on the role of verbal mediation in PS and concluded that some forms of verbal labelling or pretraining had facilitating while others had inhibiting effects.

The effects of language abilities in the Ss has also been studied. Stafford (1966) found that monolingual students solved more switching light patterns problems than bilingual students.

Language factors undoubtedly play a major role in several stages of PS. In the initial presentation of information and directions almost inevitably some types of verbal activity -- reading or listening at least -- are likely to be involved. Ongoing activity in solving the problem is likely to involve the manipulation of symbols which have names or objects which might be labelled. Presentation of possible solutions is also likely to involve language. Throughout the process it seems likely that language factors inherent in the task as well as verbal abilities (to be reviewed later) will influence success in solving problems. While it may be impossible to devise meaningful language-free tasks which would make no demands upon subjects' verbal abilities, it nevertheless appears that reduction of language factors, particularly reading demands, should lead to a purer measure of PS skill.

Factor Analytic and Creativity Variables

Factor analytic studies and creativity test development have yielded a number of variables which are probably elements of complex PS behavior. The most notable work in this area is that carried forward by Guilford and his associates. This work, as it relates to PS, was summarized in a chapter on "Problem solving and creative production" in his book The Nature of Human Intelligence (1967). Guilford notes that a number of researchers have attempted but failed to find a unitary dimension of PS ability. He goes on to note that tests designed as PS tasks yielded instead factors identifiable in his "structure-of-intellect" model as verbal comprehension (CMU), conceptual foresight (CMI), originality (DMT), and semantic elaboration (DMI). The typical arithmetic reasoning test is likely to involve general reasoning (CMS), verbal comprehension (CMU) and visualization (CFT). Guilford goes on to propose a complex model of PS behavior (as reviewed in section one) which also places substantial reliance on a memory or storage aptitude and on evaluation or judgment functions.

Torrance (1966) developed the Torrance Tests of Creative Thinking which purport to measure basic aspects of creative thinking and PS processes. Verbal and figural tests are included in this battery. These tests yield factor analytically-oriented scores for originality, flexibility, fluency and elaboration each being represented verbally and non-verbally. In the verbal battery examinees are shown a picture and asked to (1) list questions they would have to ask to find out what is going on, (2) list causes for the action, and (3) list the consequences of the action; showna stuffed toy and asked to list ways to improve it or make it more fun to play with; list uses for discarded objects; ask questions about tin cans, and think of consequences of an improbable situation. The nonverbal sections all involve drawing and providing titles. All of these tasks, many of which are related to earlier prototypes developed by Guilford for use with adults, involve behaviors which are related to the complex behavior of solving problems but generally do not represent the entire process of PS. In the technical manual for these tests Torrance (1966) defines creativity "...as a process of becoming sensitive to problems, deficiencies, gaps in knowledge, missing elements, disharmonies, and so on, identifying the difficulty; searching for solutions, making guesses, or formulating hypotheses about the deficiencies; testing and retesting these hypotheses and possibly modifying and retesting them; and finally communicating the results." Many elements of this definition (our underlining) reflect aspects of PS.

Werdelin (1966) carried out two factor analysis studies of PS behavior in mathematics. Consistent with Guilford's results, he reported that the first and largest factor to emerge was general reasoning. The third largest factor to appear, again consistent with Guilford, was verbal comprehension. The other factors were deductive reasoning, a space, and numerical ability. He concluded that the factor of general reasoning was the most important factor or aptitude in arithmetic PS.

Merrifield, Guilford, Christensen and Frick (1962) carried out an extensive factor analysis study of PS processes. They proposed that the typical total PS process has five phases: preparation, analysis, production, verification, and reapplication. For the production phase they selected a large battery of representative tests, many based on the "structure of intellect" model. They hypothesized that this one phase would involve at least six intellectual factors. Three criterion PS tests were developed and used. Their results indicate that there is no unitary factor of PS ability. Two factors emerged which had significant common variance with the criterion PS tasks: ability to list attributes of a specified goal or desired situation and ability to educe logically sufficient antecedents to a specified situation. Contrary to research cited earlier general reasoning was not a significant factor showing common variance with the criterion PS ability. Furthermore divergent production of (1) semantic units or (2) semantic relations was not related. The latter are typical fluency or brainstorming functions.

These results of creativity and factor analytically oriented research indicate that general PS behavior is a complex package of factors or aptitudes. Thus, global PS behavior might be measured in parts or pieces as well as a whole unit. Measuring the elements or parts would have the advantage of yielding assessments of parts of the total behavior and would not depend entirely on total performance to yield a single final solution.

Memory

Guilford's (1967) model of the processes in human PS is built upon memory storage. Guilford asserts that memory has an important effect on several other processes in PS. Associative models of creative PS generally stress the concept that S's ability to hold and selectively retrieve information is essential. Guilford's model also implies that memory storage is essential to hold information momentarily during complex sequential PS activities.

Weir (1967) compared 6-year olds, 9-year olds, and adults who were given memory aids during PS tests. He found that the memory aids were advantageous to the 9-year olds, disadvantageous to the 6-year olds, and had no effect on adults. However, in subsequent efforts to replicate the results (1968) the author reported that he was unsuccessful. That is, the effect on 9-year olds, as distinct from effects on 6-year olds and adults, was not replicated.

Pollert, Feldhusen, VanMondfrans, and Treffinger (1969) reported on a study of the role of memory in divergent thinking. They used the Minnesota Tests of Creative Thinking and three memory tests: word span, verbal details, and visual details. They found eleven of 40 correlations between divergent thinking and memory scores significant. In stepwise multiple correlation of IQ and the memory scores on each DT score, 17 of 19 predictors were memory scores. A canonical correlation of the memory and divergent thinking scores yielded a first root of .61. These results clearly indicate that memory is a significant positive function in creative thinking.

Saugstad (1952), however, reported that certain tests of incidental memory were negatively related to creative PS. His tests of memory involved recall of detail in pictures. He interpreted these results as indicating that subjects who recall details suffer from functional fixedness which blocks them from success in higher level cognitive activities.

Miller, Feldhusen and Asher (1968) investigated the relationship between student nurses' performance on two memory tests and their success on problems on State Board Examinations. The memory tests involved recall of names and recall of numbers for objects. They found no significant simple correlations nor were the memory tests even significant predictors in multiple regression analyses.

The results of these studies of memory factors in creative thinking and PS, while slightly contradictory, probably indicate that memory functions, closely related to the task, are of considerable importance in creative thinking and PS. Memory undoubtedly serves as the storage unit for more or less information which might be useful in solving particular problems. Facility in retrieval is an essential function during PS. Similarly holding partially processed information which may be needed at another stage and holding rejected information are also essential functions during PS. It seems likely then that memory factors would be substantial determiners of a child's success in PS. Guilford (1967, p. 319) concludes, finally, that there is unanimous agreement that successful creative PS depends powerfully on a store of information.

Personality and Motivational Variables

Personality and motivational variables probably affect PS behavior indirectly by serving as arousers and sustainers of behavior or as distractors which inhibit the cognitive processes involved in PS. It is probably at the initial stage of first awareness of a problem that arousal occurs or does not occur as the case may be. Sustaining behavior directed toward solution, particularly when success comes slowly or imperceptibly certainly demands attitudes and motivational conditions in the individual who faces the problem which will offset inclinations to give up or abandon the problem.

Perhaps the most clearly related variable is rigidity-flexibility. Flexibility is approached both as a cognitive variable or process and as a personality dimension. Nevertheless its effect is the same in both cases, namely a narrowing of response potentials or behavioral alternatives which limits the individual's capacity to be open to the full range of potential actions or solutions for the problem Freedom or flexibility to consider all possible alternatives hypotheses, to call forth relevant information, to try various alternatives, seems to characterize creative PS.

Cackowski (1969) did a theoretical analysis of personality functions in creative PS using Kekule's discovery of the benzene formula as a critical example. In his analysis he considers various explanations for the discovery such as personal courage, keen awareness of the criterion solution, and diverse educations and personal interests. However, he finally concludes that the most important feature of the creative PS process is ability to break out of previous patterns of thinking - in short, flexibility.

Guilford (1967) also noted that creative people are likely to be independent thinkers who are not inclined to follow rigid, prescribed patterns of thought. They are able to exercise flexibility and break out of routine or rigid ways of thinking.

Cunningham (1966) links the problem of rigidity in PS to time pressures. That is, time pressures plus external demands cause the individual who is faced with the problem to view it narrowly. Flexibility he argues requires time and freedom to remove oneself from the problem situation and to search for and examine alternatives. In his own research Cunningham found that exposing Ss to one class of problem, not several types, produced efficiency in solving that type of problem but more rigid inability to solve other types of problems.

Ackerman and Levin (1958) and Adams (1954) investigated the effects of teaching one or two solutions to a problem and subsequent success in solving new problems. Neither found facilitation of transfer or increase in PS proficiency through these efforts to induce flexibility.

Cowen (1952) studied the effects of stress induction on rigidity in PS. Rigid behavior was significantly more evident in the stress treatment than among non-stress Ss.

The rigidity-flexibility dimension seems to be clearly related to PS behavior as a peripheral personality process. It also seems likely that time pressures and external demands heighten rigidity. The work of Wallach and Kogan (1965) in devising non-stressful conditions for creativity testing which yielded apparently purer measures of creative thinking is relevant here. It may well be true that their non-stressful method of testing reduced rigidity and thereby enhanced creative thinking. Hopefully the same results should hold for PS.

Anxiety has also been investigated in relation to PS and creativity Maltzman, Eisman and Brooks (1956) found no relationship between anxiety and PS. Feldhusen, Denny and Condon (1965) found a low negative correlation of -.16 between anxiety and flexibility. Denny, Starks and Feldhusen (1967) found a significant negative correlation of -.24 between anxiety and originality. These studies suggest a possible low negative correlation between PS and anxiety. As noted earlier the relationship may show itself chiefly in the form of rigidity induced by the anxiety.

Expectancy for success has also been investigated as a process variable in PS. Tyler (1958) gave encouraging or discouraging messages to S during PS and found that encouraging messages which predicted success facilitated PS success.

A variety of personality variables are being investigated by Banta (1969) in the Montessori Research Project. Among the variables being investigated are curriosity motivation, persistence, control of impulse, exploratory behavior, and rigidity. Results so far show all to be somewhat related or involved in PS.

Guilford (1967) suggested other motivational factors which are a part of PS. Among these are achievement motivation, general curosity, preference for novel experiences, preference for complexity, need for adventure, and tolerance of ambiguity. Undoubtedly many other factors may be relevant. For the purposes of this review, however, the most important variable discussed is rigidity-flexibility which is probably a result of anxiety or stress induced by time pressure and external demands which should be controlled with testing techniques of the type developed by Wallach and Kogan.

Cognitive Complexity

Cognitive complexity refers to *S*'s ability or preference for simple or complex stimulus configurations. Karlins (1966, 1967) investigated the relationship of integrative complexity to performance in a complex PS task. Related work by Streufert and Schrader (1965) also is concerned with this same problem. In general the results are predictable from theory which hypothesizes that integratively complex *Ss* are able to examine a greater number of dimensions of a problem and produce more hypotheses concerning possible solutions. Integratively complex *Ss* conduct a more active search and ask for different types of information. For the purposes of this review it appears that some control of this variable can be achieved by holding the need to search to a minimum in tasks developed.

Questions, Strategies, Patterns

Blank and Covington (1965) asserted that asking questions is a fundamental process in PS. Accordingly they developed a program of instruction to teach question asking behavior. They found that the program did increase *S*'s ability to ask questions significantly. Children so taught also scored higher in science test problems and were more active in class participation.

Anderson (1965) investigated the effects of training to test hypotheses in a systematic fashion upon PS behavior. In effect this was training in the use of a strategy. The training and criterion tasks involved complex stimuli in which *Ss* had to discern the relevant stimulus. Training consisted of getting *Ss* to vary one characteristic at a time. The results indicated that the program was successful in teaching the strategy. All of these researchers (Blank and Covington and Anderson) reveal basic dimensions of the PS process which should ordinarily be acquired in a comprehensive training program and should therefore be measured in a testing program. That is, adequate testing of PS skill will involve measuring components, not just generalized skill.

Meaningfulness and Principles

Meaningfulness is probably both a motivational and a cognitive variable in PS. In an individual's initial encounter with a problem situation and in his continuing direction of interest and effort to it, meaningfulness is undoubtedly a personal variable which induces interest in working on the problem. That is, in part, meaning is a result of personal relevance. This meaning might derive simply from recognition of familiar phenomena in the PS situation or from a sense of personal involvement. The latter implies that the individual has some personal stake in the problem situation. The thing at stake may be something he wants or it may be related to his need to protect ego.

From the cognitive side meaningfulness may mean that the individual who is confronted with the problem has already learned something or has preexisting cognitive structure (Ausubel, 1968) to which elements or all of the problem situation are related. Later in working on the problem it will probably come about that these preexisting cognitive structures or information associated with them will provide useful information for solving the problem. The process of selective retrieval of structures or information is essentially cognitive but is guided by judgmental or evaluative filtering functions as Guilford pointed out (1967, p. 314).

Scandura (1966) investigated the relationship of prior practice or knowledge to subsequent PS behavior or performance. Prior practice or knowledge was controlled by providing it or withholding in the PS experimental situation. He found that the prior practice or knowledge was more important than repeated practice on criteria PS tasks or hints or cues in facilitating PS performance.

Cronbach (1948) discussed the problems of meaning in PS behavior. He particularly urged that a distinction be made between puzzles and problems. Much PS research has used puzzle-like tasks rather than genuinely meaningful problems. Puzzles are generally characterized by single solutions whereas real life problems are likely to have multiple solutions. Because a single solution is implied puzzles also constitute a unique threat to ego. There are no intermediate levels of success. Thus, it is necessary to be cautious in generalizing from PS research which employed puzzles to PS situations which involve life-like meaningful problems.

Perhaps the greatest meaningfulness may be derived from PS activity or training when principles or concepts are used in or are derived from PS activity. Katona's work (1940) indicated that PS was facilitated when general principles were derived from encounters with one or a series of problems. Specific drill or repetition of particular solutions was less helpful. In subsequent encounters Ss who had derived the principle were more effective in solving new problems than Ss who had not derived the principle. However, Butts (1965) tested the relationship between PS behavior and knowledge of science facts and principles and found an extremely low correlation ($r = .14$). Of course, this could simply imply that the test of science facts and principles did not measure facts and/or principles which were clearly related to the new problem situation. Thus, it might have constituted a bad test of the theoretical relationship between PS behavior and use of principles. Of course, it is also possible that the facilitating effect of principles on PS behavior is simply one small element among a number of facilitating processes and a larger relationship should not be expected.

It seems likely that prior knowledge or skills, meaningfulness and use of principles in PS are factors which should be considered in the design of PS tasks. Butts (1965) also described critical behaviors in meaningful PS and a tab-item approach to assessment of those critical behaviors. These critical behaviors included (1) early formation of a clear hypothesis, (2) specific experimentation with relevant variables as contrasted with random guessing, (3) introduction of control to test the validity of the hypothesis selected, and (4) specific attempts at verification of the hypothesis. Assessment of these critical behaviors would invariably involve a meaningful problem situation in which relevant principles could be evoked in working toward a solution.

III. Instruments

In reviewing the various instruments which have been used as measures of problem solving, the following types of problem solving tasks will be discussed: (1) puzzles and tasks of an insight nature, (2) thought problems involving verbal or arithmetic reasoning, (3) general inquiry tasks, (4) tasks designed to investigate the PS process, (5) factor analytic and creativity tests, and (6) simulation games. These PS measures will be evaluated according to several current models or guides to the creation of problem solving measures.

Puzzles

As they were originally conceived, problem solving tasks typically involved some type of puzzle or problem far removed from real-life situations and previous experiences. There is usually only one right answer to this type of problem, which involved some form of insight learning. A classic example of this type of problem is the two-string problem (Maier, 1945), where two strings which are seen hanging from the ceiling are to be tied together. The problem solver also has several other objects available to him including a pair of pliers, and after realizing that he cannot reach both strings at once he must discover that the pliers can be used as a weight to swing one string over to reach the other. A variety of similar problems involving discovery or insight and the manipulation of some type of apparatus are outlined by Ray (1955), including the water jar problems which have been extensively used. In this task the subject is told to imagine that he has two or three containers of specified sizes and he must tell how he would use the containers to secure a given amount of water.

Another group of tasks requiring insight learning are the matchstick problems (Katona, 1940), where the problem solver must move a given number of matches to form a certain number of squares from the original figure. Once various relationships are seen between the square this information can be used to solve many problems of this type. Katona has designed this task to measure the ability to discover or understand intrinsic relationships, since he considers problem solving to be the changing or organizing of given material.

Anagrams are another puzzle-type task that have been frequently used as a measure of PS ability. The basic anagram problem involves the rearranging of a group of letters to form a word. There is usually only one common solution, and difficulty has been shown to be related to the frequency of the solution word and the degree of displacement of the letters from the correct order (Mayzner and Tresselt, 1958). A variation of the anagram which has also been used as a measure of PS is the construction of as many words as possible from the letters contained in a given word, such as antelopes (Treffinger, 1970).

Using a task of this type, where words were generated from a given word, performance was found to correlate significantly with paired associates learning and with IQ (Stevenson and Odom, 1965). The authors concluded that this task was essentially measuring the subject's ability to organize and use verbal material directly.

Ray (1955) is critical of puzzle-type tasks in general, since they can usually be scored only on a two-step continuum of pass-fail scores. He sees the ideal PS task as one which provides a longer scoring continuum, through either a series of problems of one type or through the use of tasks which include several steps or subgoals on the way to a final solution. Another of Ray's concerns is providing the experimenter with a maximum amount of knowledge about what the subject is doing during PS or what hypotheses he is trying out. Problems of an overt manipulative manner reveal many of the subject's thought processes. However many of these manipulative tasks also require other special abilities or knowledge, (such as verbal abilities in solving anagrams, or arithmetic ability in difficult water jar problems). Where specialized knowledge is required, it should be provided and not assumed.

One of the most ambitious efforts to observe a wide variety of behaviors during PS was carried out by Klausmeier and Laughlin (1961). Their observation included: (1) manipulation or nonmanipulation of objects available as part of the problem, (2) engaging in nontask activities or withdrawing, (3) offering an incorrect solution, (4) noting and correcting mistakes independently, (5) verifying a solution by checking, or (6) using a random or logical approach to the solution.

Thought Problems

The PS measures used in many studies can be described as thought problems involving verbal or arithmetic reasoning. Tate et. al. (1959) constructed a group of problems for 7th and 8th graders involving reasoning in practical situations. Several relied on basic arithmetic skills and others were of a logical deduction type. The information needed to solve most of the problems was given within the problem itself, although the problem was read by the subjects with no illustrations and results correlated highly with intelligence and reading ability. Other similar problems also used by Tate presented a problem situation and asked what information was necessary to solve the problem. This type of task discriminated well between good and poor problem solvers.

An arithmetic PS task which was graded to fit subject's ability level was developed by Klausmeier et. al. (1959). Subjects were asked to identify the pieces of money necessary to make a given total amount using a specified number of pieces of money. A similar type of task was used by Treffinger (1970) in a PS battery. It involved the subject's deciding how he could spend exactly fifty dollars to buy cows, pigs, and chickens, each at given prices. The subject was encouraged to find as many solutions as possible.

In an attempt to avoid the obviously strong verbal components of written story problems and the associated cultural influences, the Davis-Eels Games were developed using illustrations only and spoken instructions. Responses are made by indicating which statement correctly accounts for the situation illustrated or by selecting the picture in which a particular problem is being solved in the most effective manner. In another type of problem involving coins, the subject must indicate which of three pictures shows the best choice of coins to begin to make up a certain amount out of other pictured coins. Although all the instructions are given verbally, they do become rather complex, especially in this section on coins. A study designed to determine to what extent the Davis-Eels Test is free of cultural factors (Angelino and Shedd, 1955), found all differences to be significantly in favor of the upper socioeconomic group. These results were taken as evidence of the influence of cultural factors in this test.

Cronbach (1955) outlined some concerns about meaningful problem solving which directly apply to the development of thought or reasoning problems. His primary concern is that meaningful PS can take place only when the problem has meaning for the student. Unless problems are realistic for the learner, it becomes a task of manipulating abstract symbols. Problems can, however, be made meaningful to the learner by giving him the necessary experience, either directly or vicariously. Pictures can be a useful tool for giving more meaning and realism to reasoning problems, although care must be taken to avoid complicated verbal instructions. On the other hand Cronbach states that problems must not degenerate into mere exercises, since exercises make small demands on higher mental processes. Interference in effective PS occurs when the learner feels no desire to solve the problem for its own sake, but is working only to find an acceptable answer or to avoid unfavorable consequences. It is therefore very vital that the problem be realistic and interesting for the student, so that he will accept it as something he would really like to solve. In this way, distracting emotional factors can be removed.

Inquiry

A variety of problem solving measures have been developed in the general area of inquiry. These measures usually take the form of problematic situations which are presented for the subject to respond to in a variety of ways. A classic example of this type of measure is the material developed by Crutchfield and Covington (1966). A definite attempt is made to use problems or situations that will be of interest to the subjects. Given certain information, subjects are asked to hypothesize solutions consistent with this information and with the clues provided. Responses are open-ended and often the subject is asked to generate many solutions, instead of just one.

The Crutchfield and Covington materials require the subject to do much reading and respond by writing out many fairly long explanations or reports, which suggests a strong connection with verbal ability.

Miles (1968) has developed a similar set of inquiry-type problems for students of college age, known as the Creative Design Test. He is critical of many other PS tests in that their problems are brief, testlike and artifical, often unlike any common PS situations. Miles stresses that valid problems should also have subject or occupational relevance, and so general design was chosen as the occupational subject area for this test. Problem situations are presented which are realistic or plausible for college students, such as devising ways to increase the business of a local laundromat by encouraging students to use it. Subjects are told that their responses will be judged on the basis of total number of ideas, originality, variety, and feasibility. Form and style of response are not judged and no specific time limit is set. Adequate scorer reliability was obtained for three of the five items. He found some evidence for construct validity of his tasks in correlation with fluency and originality tests by Guilford and Torrance.

A similar problem format was used by Treffinger (1970) in a PS test designed for fifth and sixth graders, with multiple solutions requested to practical problems, such as keeping the neighbor's weeds out of your yard without offending him; or finding ways of changing school to make it more relaxed and comfortable, while still learning everything you should. This type of problem has the advantage of being current and relevant in the subject's experience, but it also provides scoring difficulties. Furthermore only the product is obtained, not how it was obtained.

Another inquiry-type measure has been developed by Suchman (1962) which presents the problem situation on film instead of in written form. Here a physical event is shown which has been designed to disequilibrate the learner by presenting something which he cannot fully explain or could not have anticipated. Questions are then posed about the cause of the event in an attempt to motivate the learner to find an explanation.

Investigating the Problem Solving Process

In his analysis of problem-solving measures in general, John (1957) stales that it is desirable to make the PS process itself accessible for direct observation by developing a technique to externalize the process. A variety of instruments have been developed in an attempt to accomplish this goal. One measure which has been developed in the subject area of biology (Koos, 1970) attempts to assess various inquiry skills in high school students. Using multiple choice responses, subjects are asked to proceed with a step-by-step investigation of problems which have been presented in a series of pictures. The problem booklet is constructed in a branching format, so that each student can follow paths of investigation which seem most meaningful to him. Students are asked to interpret diagrams and passages in an effort to solve the problem. Corrective and review features are also included in the program. Socring is based on points for choices judged preferable by the authors, and the paths each student took are also recorded.

A more widely used method of analyzing the PS process is the tab item (Glaser et. al., 1954; Rimoldi, 1960). Subjects are presented with a problem and also a number of questions which they may ask to obtain more information for solving it. Subjects pick the questions which they want answered and remove the tab on the question card to find the answer. Since the tabs cannot be replaced, a permanent record then exists of which questions each subject chose. Subjects are usually instructed to try to solve the problem using as few questions as possible. Rimoldi (1960) records the order in which questions are chosen and also the time taken to complete the test, with the correct answer being selected from several proposed solutions. This type of item has been used with subjects 7 to 13 years old in an attempt to measure the influence of logical structure and language in problem solving (Rimoldi et. al., 1968). Erdmann and Buchi (1970) have compared the subject's tactic, as indicated by questions he asks, to an ideal tactic composed of the most relevant questions in proper order. An example of the type of problem used is locating a preselected area in a geometric figure composed of many parts by using questions chosen from those provided.

Butts (1965) developed another form of the tab item test. where instead of choosing which questions he wanted answered, the subject chose data which he thought could be used to solve the problem. The data provided was of four types: relevant, additional, redundant, and irrelevant. Subjects could be judged on the types of data they chose and on the solution they selected from those provided. A tab-item test involving the use of either principles or specific facts to solve problems was developed by Cross and Gaier (1955). All problems were solvable by choosing either principles or facts, but more errors were found to occur in the solutions of those who used the "easier" facts method. Willingness to use principles was also associated with high math achievement.

Factor Analytic and Creativity Tests

A number of aspects or elements of creative problem solving are undoubtedly measured by factor analytically oriented tests such as those developed by Guilford (1967) and his associates or by creativity tests developed by Torrance (1966). In his "structure of intellect" model Guilford asserts that it is chiefly factors or abilities in the class of operations called divergent thinking and products of all six types, but especially implications and transformations, which constitute creative thinking and which are probably elements of creative problem solving. Other tests in Guilford's "structure" under the operations of cognition, memory, convergent thinking and evaluation are also elements of creative problem solving.

Some of the tasks under divergent thinking are particularly relevant to creative PS. Divergent production of class ideas, as represented by the test in which Ss must list all possible uses of a brick, is probably relevant to multiple hypothesis generation. Divergent production of systems is represented by a test in which S must write as many sentences as possible with a specified number of words in which the first letter of each word, in order, is given. Divergent production of transformations is represented by the well known match problem (take 4 matches away and leave 3 squares). Originality or adaptive flexibility with semantic material is represented by a test in which Ss must write titles for brief stories.

Torrance (1966) developed the Torrance Tests of Creative Thinking which are in two parts, verbal and figural. The verbal tests ask Ss to examine a puzzling picture and (1) ask as many questions as they can think of to clarify it, (2) list causes for the action, and (3) list its consequences. Other verbal tests require Ss to list ways to improve a stuffed toy, list unusual uses for old tin cans, ask unusual questions about tin cans, and list all the results they can think of for an improbable situation.

The figural tests of the Torrance Battery ask Ss to (1) draw an original picture around a colored glob which is provided, (2) draw picture completions for each of ten irregular lines, and (3) draw pictures incorporating circles which are given.

These tests by Guilford and Torrance are clearly problematic in nature, albeit miniature or sub problems. Nevertheless they suggest the possibility, particularly Torrance's three tasks based on the picture, that tasks can be designed in which the problem is based on one general problematic situation and directions to Ss for soltuions can be broken down into a series of steps.

Simulation

Simulation approaches to PS skill assessment or training typically involve the use of comparatively large and realistic problem situations in which motivational factors are apt to run high. Substantial realism is sought in the presentation and conduct of the problem. All of the relevant or important psychological processes which are present in a real problem situation are sought or elicited in the simulation problem situation. Of course, simulation always involves some or much miniaturization or compression of real problem events, and real risks or complications are removed. Essentially the simulation attempts to model the processes which are involved in real life and to strip away nonessential details or activities in which the researcher would have no interest.

Major work on simulation has been carried out by Streufert and others (1967, 1968, 1969) whose simulation of war games problems is used as a basis for additional investigation of cognitive complexity and information processing variables in problem solving operations. An elaborately simulated command post with quite realistic communication in and out is used to carry on a lengthy war problem which typically runs five to eight hours. All communication systems are controlled by E who can modify messages among Ss as he chooses and collects a wide variety of data about Ss' behavior while the game is in progress.

Guetzkow and Jensen (1966) described the simulation project on International Relations which they have carried on at Northwestern University. Political-military decision making is studied with simulation problems which are to a great extent computer controlled. Messages to Ss and Ss' responses are moderated by the computer which also comes to serve then as the observation unit to secure information about Ss' behavior.

Guetzkow (1964) and Cherryholmes (1966) reviewed research and theory development in the use of simulations and concluded that the prospects for the use of simulation in measurement and training are encouraging. Guetzkow particularly notes that emotional involvement of Ss runs high in his simulation games. Cherryholmes suggests that the evidence is conclusive that interest and motivation run higher in simulation than in any other kinds of assessments or training procedures. Frequently, of course, it is the sense of competition in simulation games which elicits the higher motivation.

Speedie (1970) reviewed research and development of simulation games. Descriptions of four major developments are given next:

> The John Hopkins University Department of Social Relations (Coleman, 1968) has produced a number of simulation games such as the Democracy Game (simulation of a legislature), the Life Career Game, the Community Response Game (simulation of a disaster in a community) and the Parent-Child Game. All their simulation games center on simulations of social processes. A central feature of each of these games is the process of role-playing. In the Democracy Game, each player takes the part of a legislator trying to be reelected. The role of an individual making career choices is taken in the game of Life Career, and the role of parent or child is assumed in the game of Parent-Child. Thus in the simulations employed by these games the player operates the model of a social environment by assuming the role of a particular actor in that environment.

The model of the social environment consists of two parts, the social predispositions of the players and the rules of the game. Coleman (1968) states that the model is established by having each player in the game act as a portion of the social environment of each other player. The rules of the game then establish the obligations upon each role, and the players operate the simulation by acting within the rules governing their respective roles and interacting with each other. He goes on to detail the five kinds of rules found in such models. The first is the procedural rule which describes how the game is put into play, and the general order in which events proceed within the game. The second type is the mediational rule which specified how impasses or conflicts between players are resolved. And the third type is the behavioral constraint rule or the specific role expectations for the various players. A fourth type of rule specifies the goals and their means of achievement. The fifth and most important type of rule from a simulation point of view, is the environmental response rule which specifies how the environment would behave if it were part of the game.

Boocock (1968b) investigated the effects of two specific games in an experiment conducted at a 4-H conference in California. Two games were used. The first was the Life Career Game, which purports to simulate certain features of the labor, school and marriage "markets" as they now operate in the American society. It attempts to inform students about the kinds of decisions that must be made about jobs, further education or training, family life and use of leisure, and the probable consequences of the various decisions given the personal characteristics of the person making them. The game is played by teams which deal with fictitious individuals' profiles. Time is divided into decision periods in which each team allocates the players' time and money. At the end of each period, scores are computed in four areas - education, occupation, family life, and leisure - by the use of tables and spinners based on U. S. Census data and other national survey data, and resulting outcomes are predicted. These tables and spinners constitute the simulation model. The team goal is to acquire a maximum number of points during ten decision periods.

The second game, the Legislative Game, was designed to teach the basic processes of negotiation through which collective decisions are reached on issues in which different segments of society have differing interests. In this game each player assumes the role of a state legislator, and is charged with getting legislation passed which his constituents favor. The goal of the game is to be reelected. The simulation model consists of the parliamentary rules of the legislature and the rules governing the "bargaining" sessions.

Baker (1968) presents some more direct evidence concerning the effectiveness of simulation games. Two classes participated in a simulation game in which each individual was a member of one of four nations which had to deal with mutual problems similar to those existing in the time period studied. Each student took the part of a government official and was charged with carrying out the policies of his country and making it grow, prosper, and maintain its prestige in a World Council. Ground rules were provided and the interactions of individuals and groups served as the simulation model.

In another example of simulation games versus "conventional" instruction, Wing (1968) examined the applicability and effectiveness of two computerized economics games. The first was the Sumerian Game, in which the student assumed the role of priest-ruler of the ancient city-state of Lagash, and was charged with making decisions concerning the allocations of economic resources. Natural disasters and technological innovations are introduced at various intervals. In later stages the student was given the opportunity to develop crafts and international trade. In the second game, the Sierra Leone Development Project, the student deals with similar problems in a modern context as an AID official in Sierra Leone.

Speedie (1970) also reviewed research and evaluation of simulation games. He concluded that the research is inconclusive and that further work should concentrate on the following problems: (1) fidelity of the simulation with respect to the real world, (2) the degree of compression or expansion within the model, (3) the complexity of the simulation model and the number and difficulty of the rules of the game, (4) the number of people involved in a game, (5) the degree of competition, (6) the degree of knowledge the players have of the situation and the rules at the beginning of the game, and (7) the degree of role identification of each of the players.

These simulation games offer models of substantial interest for the development of PS tasks. Essentially they suggest the use of a more elaborately developed problem situation; the use of more realistic or relevant (for S̲s̲) tasks; the induction of motivation through meaningfulness, competition, and personal involvement; the use of various materials and devices in simulating the problem situation and not limiting problem presentation to printed statements; and the seeking of ways to observe PS behavior throughout the full sequence of its stages.

General guidelines for PS tasks

In his suggestions for the development of PS measures, Keislar (1969) stresses that the population of problems being used should be clearly defined and should also be important to learning in general, or easily generalized to other problem solving areas. He questions the validity of puzzles or anagrams as PS tasks which can generalize to other learning. Keislar also states that pupils should not be penalized on a test of problem solving for an inadequate understanding of the concepts, principles, or vocabulary involved. The material involved should be familiar to all, or be taught in the course of the task. John (1957) also encourages this in stating that the ideal format for PS tasks should start the subject with a standard minimum of information and require him to structure his own presolution behavior with a minimum of external constraints, so that the task is free of special skills, knowledge, or experiences peculiar to a given culture. The subject should also be interacting with real rather than abstract events, he further explains.

Concerning the scoring of the tasks, Ray (1955) feels that the task should provide a scoring continuum longer and more useful than just correct or incorrect and that it should provide the experimenter with the maximum amount of knowledge about the PS processes used by the subject. The conditions for giving the test should be clearly specified, Keislar urges, especially where hints or clues are employed to see how much assistance the learner requires. A further suggestion he makes is that films or other audio-visual aids are useful for presenting test items to groups of students. An experiment by Miller (1968) presented a variety of PS tasks on film to whole classes at a time, and answers were recorded in booklets which coincided with the filmed material. Tasks used were paired associates, discrimination learning probability learning, incidental learning, conservation of volume, and anagrams. Great variance of scores on tasks within each type were found, suggesting that the content matter of the task is at least as important as the form it takes.

IV. Conditions of Testing, Cues, Guides

Conditions inherent in the testing situation apparently exert a profound influence on S's performance during PS. Standardized achievement testing lends itself to a high degree of uniformity and control. Yet even there the personality manifestation of the examiner and his control of related conditions may exert a substantial influence on PS behavior. A stern or harsh examiner induces anxiety which inhibits students' performance. A careless examiner permits time limits to go astray. An examiner who is inadequate as a disciplinarian may permitsto develop in the testing room. The examiner or the test directions may fail to communicate the true nature of the task or the problems. All of these conditions would limit S's ability to perform adequately on the task.

Adequate performance on the task may imply that the assessment of PS behavior is simply an assessment of typical performance. Cronbach (1963, p. 213) distinguishes between two types of assessment and the related motivational conditions: (1) performance with strong school motivation and (2) and performance with typical school motivation. The former is an assessment of maximum performance, the best that Ss can do. The latter attempts to represent their typical performance. It seems likely that measures of PS behavior should be measures of maximum ability or performance. However, S's typical or habitual techniques or skills in PS might also be of substantial interest if we wish to generalize to typical out-of-school real life situations.

Hints, Clues, Guides

Information, hints and cues necessary to success in PS might be retrieved by S from memory storage, acquired during the PS task, or provided under controlled conditions by the examiner. Provision by the examiner is one way of controlling the effect of differential backgrounds of knowledge or specific skills among Ss. Providing needed knowledge or skills also affords the examiner an opportunity to observe how Ss use the information or skill in work on the problem.

Scandura (1966) provided both specific knowledge and skills as a prelude to criterion PS tasks and found that both were much more effective than repeated PS practice in improving S's ability to solve problems. Klausmeier, Feldhusen and Check (1959) presented money problems to third and fourth graders and gave cues or hints at four minute intervals as long as Ss had not solved the problem. The cues or hints were graded to offer increasing assistance so that Ss became more likely to solve the problem as they progressed from hint to hint.

Burke and Maier have carried out a series of studies with others on the use of various types of pretraining, cues and hints on subsequent PS behavior. Hoffman, Burke and Maier (1963) reported a study in which Ss were first given experience in working a simple version of the hatrack problem while control Ss received no pretraining. Contrary to expectation control Ss performed significantly better than experimentals on the criterion (more complex) hatrack problem. Later Burke, Maier and Hoffman (1966) studied the effect of hints before or during PS activity on attainment of solution to the hatrack problem. Hints pointed to crucial aspects of the situation which would be essential in solving the problem. They concluded that different hints may vary in their effectiveness, that hints may have a disruptive or distracting effect when introduced after PS behavior is in progress, and that hints introduced right after the directions and before PS behavior begins are most effective.

Maier and Burke (1967) next studied the effect of hints (1) right after directions, (2) during PS behavior and (3) after Ss had run out of ideas and found that the timing of the hint did not influence subsequent PS activity. Furthermore there was no difference between a good and a poor hint on subsequent PS activity. They did find, however, that the hint did have the effect of eliminating subsequent PS activity incongrous with it. Recently Burke (1969) reported a study in which positive and negative versions of hints were used, again in connection with the hatrack problem. Results indicated that the negative hints which eliminated incorrect solutions were most effective in facilitating PS behavior.

Dreistadt (1969) studied the effects of picture analogies as hints in connection with the pendulum problem. The hints were pictures of various types of pendulums which were exposed to Ss while they were working on the problem. He found that the picture analogies were effective in facilitating PS efficiency.

These studies of hints, cues and clues in PS indicate that such hints can be used effectively in facilitating S's behavior. If one's interest in assessing PS behavior is simply to determine if S can or cannot solve certain classes of problems the use of clues might be undesirable or at least unnecessary. However, carefully graded clues might still serve to provide an index of PS skill by reflecting the amount of help needed. From a quite different point of view the use of clues to sustain progress on the problem would be necessary if one wishes to observe S's behavior at all or several stages of a complex ps sequence. Thus, clues might be used to keep Ss progressing to facilitate such observation. For the present test development project the latter is a significant consideration since it is likely that the tasks to be designed for this project will involve observations of several types at several stages of PS.

Presentation of Information

Closely related to the use of clues, hints or guides is the function of information which is presented to Ss in PS. Miller, Galenter and Pribram (1960) describe PLAN as a cognitive system which the individual uses to operate upon information and thereby to guide behavior. The recall and use of information in PS may be guided by prestored cognitive units which facilitate the retrieval of bits and chunks of information. They stress that the first phase of an operation such as trying to solve a problem is the specification of knowledge or information which is necessary as a prelude to action or solution. Clearly then information, its provision, it availability, its retrieval and its use are critical aspects of PS behavior.

Corman (1957) varied the amount of information available to Ss relevant both to the principle necessary for problem solution and to the method necessary for solution. Matchstick problems were used. An interaction of method with S's mental ability was found. High ability Ss profited most from explicit information about the method or the principle while low ability Ss performed best only when information about method was provided.

Anderson and Johnson (1966) presented information critical to the solution of a problem either by means of a simple demonstration or verbally. The problem was to find the best way to facilitate pivoting of a board with weights on the end. They found that the demonstration was more effective than the verbal presentation.

Scandura (1966) studied the effects of the order in which information about a problem is presented he found that information which is available prior to S's efforts to solve the problem is more effective than hints or practice introduced later in a PS sequence.

These studies of information in PS along with studies of clues, cues and hints, previously reviewed, indicate that the amount and kind of information effectively available to Ss have significant effects on PS behavior. Obviously it is necessary to think of alternatives to verbally (printed or spoken) presented directions, information about the problem situation itself, and clues or hints provided along the way. Pictures and demonstrations would be useful alternatives in designing the tasks to be used in the present project.

Timing, Directions, Atmosphere

Time limits or pressures (speed versus power), the nature of the directions, and the climate or atmosphere generated during PS activity are also aspects of the testing situation which may significantly affect S's PS behavior. In standardized intelligence, aptitude and achievement testing the effects of speed-inducing time limits as opposed to the provision of more or unlimited time is well known. The results of speed versus power test results, while correlated, differ. Some Ss perform best under rigid time pressures, others perform best with no time pressure. In a sense the provision of incubation in creativity and PS assessment is a provision of power test conditions or unlimited time.

Parnes (1961) carried out two studies of the time when good ideas appear in a creative problem solving sequence, the first half or the last half. In the first study untrained Ss were found to produce significantly more good ideas in the last half as compared with the first half of the total testing sequence. In the second study Ss who had been trained in brainstoring were used and the total time sequence was increased from 5 minutes, as in the first study, to 15 minutes. The time sequence was divided into three five-minute units for analysis. No difference in quality of ideas was found between the first two five-minute periods but ideas produced in the last five minutes were qualitatively superior to those produced in either of the first two periods. These results clearly suggest a need for extended time limits in creative PS.

Dreistadt (1969) introduced a brief time out during a creative PS task to determine if such experimentally induced incubation could improve PS efficiency. The results were negative. That is, Ss who received the incubation inducing time out performed no better than Ss who did not receive it. Van Mondfrans, Feldhusen, Treffinger and Ferris (In press) also introduced incubation in creative problem solving assessment by giving Ss several days between problem presentation and subsequent work on the problem. They found that the performance of Ss was little different from the performance of Ss in the standardized method of presenting the tasks. In a subsequent study they found that scores obtained under this method of assessment involving incubation were quite highly correlated with Ss' grades in basic subject matter areas but the correlations were not different from the correlations between grades and creative PS assessments under standard testing conditions.

The most well known study of the methods of testing for creativity is that of Wollach and Kagan (1965). They attempted to relieve all stress or experimenter pressure on Ss and to eliminate time limits. In general they strove to create a game-like non-testing atmosphere and to induce a friendly non-threatening relationship between the examiner and the examinees. They found that creativity test scores derived under these conditions were probably purer measures of creative thinking and free of common variance with intelligence.

Klausmeier and Laughlin (1961) carried out a study of children's behavior during problem solving. Their results indicated that many children failed to apprehend the directions or forgot them if several types of subsequent behavior are used as indexes to the problem. For example, Ss failed to note and correct mistakes which related to the directions, offered incorrect solutions, or failed to verify a potential solution as they had been directed to do. These results indicate that formulation of the directions and assurance that Ss understand them may be critical aspects of subsequent PS performance.

Motivational Variables

Subject's motivation to work on the problem in a PS task has already been implied in topics discussed above. It seems likely that motivational factors have a substantial influence in arousing S to awareness of the problem, to cause a reaction in the sense of personal acceptance of the problem as a task to confront, and to sustain work or progress on the problem to solution. The results of success or failure to solve probably have a marked influence on estimates by S of his chance or probability of success on subsequent problems and on his general motivation to undertake work on the same, similar or even other problems.

Cronbach (1948) noted that a problem really exists for an individual only when he *must* produce a response or solution or when he must strive for a solution in order to achieve a sense of satisfaction. Thus, a true problem requires a tension state or motivation. It is not posing the problem that constitutes a problem, it is *S*'s acceptance of it as something he must try to solve. In many of the puzzle situations used in PS research he notes that it is merely the social pressure or personal anxiety which motivates PS behavior, not the true meaning of the problem and the value of the solution for its own sake. Most school reactions are also extrinsic, he asserts, to the problems with which teachers confront kids. The dominant motive may simply be to satisfy the teacher or to escape her wrath. Cronbach also noted that kids often expect that progress toward solution of a problem should be rapid and automatic and that when they encounter a problem in which automatic behavior is not available extreme anxiety and desire to escape may occur. Cronbach also noted that rigidity and level of aspiration are personality variables which have a profound influence on motivation. As guides to the developer of PS tasks Cronbach argued that the problems *must* have meaning for the child, they must not degenerate to mere exercises, if meaning is not inherent it should be provided as supplementary experience along with the problem, and the setting of the problem and the emotional experience of the child must be carefully considered in order to avoid debilitating effects which block the child from achieving a solution.

Kilpatrick (1969) reviewed PS research and reported a study in which *Ss*' preference for different types of problem content was investigated. High school freshmen preferred content involving social or economic conditions (e. g., selling hot dogs) as compared with mechanical-scientific content (e. g., testing spark plugs) or abstract content (e. g., solving secret codes). Problem content preference was also found to be related to *Ss*' vocational interests. Abstract problem content was particularly disliked. He also reported that needs or interests particularly associated with lower class status were not related to their success on problems which used or did not use content related to status. Differences in performance were related to difficulty, not content.

These studies indicate that motivational factors are crucial in PS situations and must be carefully considered in designing tasks. Perhaps a combination of intuition about appropriate motivation for a given group of Ss plus empirical trials and revision will be necessary to establish appropriate motivational stimulation in the PS tasks. Further, there may even be a need to consider individual differences in structuring tasks to assure meaningfulness for all examinees.

V. Individual Differences

Individual differences (ID), other than those reflecting skill or proficiency in PS, affect PS performance. Thus, a test which purports to measure PS skill, supposedly acquired as a result of some instructional program, may, to some or a large extent, be measuring ID variables instead. Perhaps the largest class of such ID variables is represented by general intelligence. Other suspected ID variables would be general reasoning, verbal comprehension, and originality (Guilford, 1967). Special types of problems such as those involving objects or numbers might evoke still other ID variables. Spatial visualization or numerical aptitude would be examples of the latter.

Keislar and Stern (1970) found that mental ability was significantly correlated with PS ability. Children with higher mental ability use a more efficient scanning strategy while children with lower mental ability tend to use a simple gambling strategy in PS. Corman (1957) also found an interaction between mental ability level and a strategy variable. High mental ability Ss performed best when explicit information about method or principle was provided while low ability Ss performed best when specific information about methods for solution were provided. Tate (1959) used several measures of general and specific mental abilities such as Davis-Eels games, Differential Aptitude Tests, and Progressive Matrices and compared scores of good and poor problem solvers on a series of thought problems. Mental ability was found to be significantly higher among good problem solvers. These several studies indicate that Ss with high mental ability will perform better than Ss of low mental ability on PS tasks, but the performance differential may also be related to other factors in the PS situation.

Karlins (1966, 1967) investigated creativity and cognitive complexity variables in PS. Mednick's Remote Association Test was used as the creativity measure and Schroder and Streufert's Paragraph Completion Inventory as the cognitive complexity measures. The creativity test was not significantly related to Ss' ability to perform the search in a PS task but Ss who had integratively more complex cognitive systems were significantly more efficient in carrying out the search in PS. They showed more breadth in their information search searched the information domain more evenly, asked more appropriate questions, and maintained more accurate differentiation among classes of information during the search.

Gorman and Breskin (1969) compared rigid and flexible Ss on a variety of PS and creativity tasks. Flexible Ss performed significantly better than rigid Ss on the following tests: semantic redefinition, inductive reasoning, and figural completion. Tate (1959) also compared good and poor problem solvers for rigidity and flexibility and found good problem solvers to be more flexible as reflected in their ability to break out of an experimentally induced set.

Frandsen and Holder (1969) investigated the effects of spatial visualization ability on PS ability. PS ability was measured with syllogism items, time-rate-distance problems, and logical deduction problems. They found that *Ss* with high aptitude for spatial visualization were superior problem solvers and *Ss* who were trained in spatial visualization became better problem solvers.

Olson, Miller, Hale and Stevenson (1968) investigated the relationship between several PS tasks and grades in school. While grades should reflect achievement as related to instruction and not ID variables, it is nevertheless likely to be true that a large component og grades will reflect ID variance. They found substantial correlations between grades and performance on probability problems, verbal memory problems, and anagrams. All problems were presented via films or workbooks.

Kilpatrick (1969) reviewed several studies of ID correlates of PS ability. In one, poor problem solvers were found to be low performers on tests of critical thinking and practical judgment. In another study reading comprehension was more highly correlated with arithmetic PS ability ($r = .5$) than computational ability ($r = .4$).

Klausmeier and Laughlin (1961) investigated specific behavioral differences in PS among children of low, average and high IQ. While no significant differences were found in time to reach solution since the problems were graded in difficulty to suit each child, other substantial behavior differences were found. High IQ children showed greater incidence than average and average greater than low in noting and correcting mistakes independently, verifying solutions, and using a logical approach. Low IQ *Ss* showed a greater incidence than average IQ *Ss* and average greater than high IQ *Ss* in nonpersistence, offering incorrect solutions, and using random approaches.

Klausmeier, Feldhusen, and Check (1959) reported an experiment in which low, average and high IQ *Ss* were given a common penny sorting task. *Ss* were given a pile of pennies, told to divide them among a specified number of friends, and required to state how many each friend would get. Hints were used to assure that each *S* would eventually achieve a solution. Low IQ *Ss* took significantly longer than average and high IQ *Ss* but the latter groups did not differ significantly.

Guilford (1967) discussed various ID factors which might be related to creative problem solving. Among these, in addition to several mentioned at the beginning of this review, are: achievement motivation, independence, possession of information, ability to incubate, ability to form schema or systems, ability to achieve insight, flexibility, ability to see implications, and ability to judge or evaluate.

These studies and reviews of the role of ID variables in PS clearly indicate a need for caution in the design of PS tasks or in the interpretation of scores from PS tests. Clearly any such scores which ostensibly reflect learning from instructional programs are likely to contain a large component of ID variance. Probably the largest component will derive from general mental ability. Other ID factors likely to contribute are verbal and/or reading comprehension, general reasoning, and rigidity-flexibility. Steps should be taken in the design of tasks to reduce the contribution of these components by offering differentiated task levels, reducing reading or verbal demands, presenting clear, easily understood directions and problem descriptions, providing a sufficiently relaxed atmosphere to avoid anxiety which induces rigidity, and assuring that differences in informational background do not confound PS test results.

VI. Development of PS Behavior

Models which have provided the most lucid description of PS and its processes have been those which viewed PS as a dynamic and productive act. The individual was considered an active participant in the process, building a complex cognitive system of relationships which could be transferred to whole classes of problem situations or which could change its own structure to assimilate new information.

Piaget's model of intellectual development most clearly underscores the growth process of such a dynamic cognitive structure (Phillips, 1969). Two extremely important building processes continually operate to generate a realistic and effective schema: assimilation and accommodation. Throughout the three major periods or stages of development, the preoperational or sensorimotor period, the concrete operations period, and the formal operations period, the processes of assimilation and accommodation work juxtaposed to each other to incorporate new information into the existing cognitive structure and to change the structure as a result of that new information.

Until the child is approximately two years old, his world is one tied almost completely to his immediate sensations. During those two years, he develops a scheme of reality based upon what he can touch and feel. The first stage of development is in every sense of the word, a sensorimotor one, for the child learns the effects of his own personal actions and reactions.

During the second and third stages the child learns to transfer his own actions to those of the external world around him. Until about 11 or 12 years of age, however, the child is not able to deal with objects and events formally or abstractly, i.e. manipulate them or their consequences in their absence, but can deal with them only concretely. Piaget, though, stresses that these stages do not possess definite boundaries and that the growing child is constantly in a state of flux, exhibiting characteristics of all operational levels. The processes of assimilation and accommodation are constantly operating, building and revising the schema.

Correlations of PS with Intelligence and Age

It can easily be seen that development of intellectual ability described by Piaget parallels the models of PS proposed by modern cognitive theorists. The processes are identical. Research by Beilin (1967) and Stevenson, Hale, Klein, and Miller (1968) provided evidence that children's PS and learning skills develop quite consistently with age. Stevenson, et. al. administered a battery of 12 learning and PS tasks to classes of 3rd through 7th graders and correlated the results with measures of IQ, achievement and ratings obtained from the teachers. Considerable increases in scores were obtained in each grade for all types of problems. Beilin administered anagram problems to Ss ranging in age from 8 through 14 years and obtained similar results.

Weir (1964), however, has pointed out that children adapt quite different PS strategies as they grow older. Younger children did not eliminate inefficient responses during probability learning tasks, and continued to make use of strategies which did not maximize reinforcement. Weir hypothesized that, with 6 and 9 year olds, this inability to disregard incorrect strategies was a function of limited memory capacities. When presented with memory aids, 9 year olds tended to operate more like the adult Ss and rejected simple, ineffective strategies.

Piaget, of course, has proposed that it is more than memory that is involved. A whole congnitive structure must be developed, with continual modification, before the child can interpret concepts such as conservation and number, for example. Until the later stages of the concrete operations period, objects do not possess a generalizable, objective form. Consequently, their weights, volumes, and relationships to other objects and events, can change depending upon the problem situation. Until an adequate schema develops, from experience, the child must make use of the laws he has developed for himself, regardless of memory capacity.

SES and PS

If environmental experiences are the crux of the developmental problem, however, then the kinds of experiences are extremely important. Children from different socioeconomic groups will undoubtedly have had different experiences. Children from lower, so-called "disadvantaged" classes may not have had the range of experiences necessary to develop adequate congitive and PS skills. Banta (1969) summarizes his research findings by stating:

1) Innovative behavior is lacking among the lower class children; it can be modified through pre-kindergarten experience, but the upper class children have a considerable head start.

2) Analytic thinking can be trained in pre-kindergarten classrooms, but again the upper class child has the advantage.

3) The upper class child makes more use of the presence of adults in his PS; the lower class child misses out on the opportunity to take advantage of adult instructions and and adult concerns.

It is obvious that effective PS behavior develops with age and amount and kind of experience. Lower SES children lag considerably behind their middle and high SES peers in such crucial thinking and PS skills as: drawing relationships, analyzing problems into parts, making use of available resources, and following directions.

Thus, in assessing PS behaviors, compensation must be provided. Measures must be developed which do not draw predominantly upon middle or upper class experiences. Levels of problem-types must be included which permit assessment at various stages of development, for biases in favor of high SES children must be identified.

Response Styles
Literature Review

The original intent of this portion of the literature review was to search the literature dealing with five variables which could be thought of as response styles. These variables were: (1) locus-of-control, (2) analytic disposition, (3) field-dependence, (4) children's social desirability attitudes, and (5) level-of-aspiration and/or expectancies for success or failure. Our preliminary review indicated that two of these variables, locus-of-control and analytic disposition, were particularly relevant for problem solving and meaningful for the study of the cognitive functioning of culturally disadvantaged children. Therefore, a decision was made early in the reviewing process to concentrate our efforts on these two variables. Some of the other variables overlapped with one or the other of these two variables (e.g., field dependence with analytic disposition and expectancy with locus of control) while others appeared, on the basis of the data available, to be less relevant to deficits associated with cultural disadvantage. The two variables selected for comprehensive review will be discussed separately below.

Locus of Control

One of the major conclusions of the "Coleman report" on Equality of Educational Opportunity (Coleman, 1966) was that ... a stronger relationship to achievement than...all the school factors together, is the extent to which an individual feels that he has some control over his destiny," and further that "...minority pupils, except for Orientals, have far less conviction than whites that they can affect their own environments and futures. When they do, however, their achievement is higher than that of whites who lack that conviction (p. 23)".

The variable to which Coleman alludes is virtually identical to the variable Rotter (1966) has called "Locus of Control," abbreviated "IE" (for "Internal" vs. "External" control of reinforcement). In Rotter's theory, IE is a higher-order expectancy variable: "Internal denotes the generalized expectancy that reinforcement is contingent upon or controlled by one's own behavior, as in an operant conditioning paradigm, and "External" denotes the expectancy that reinforcement is controlled by external forces(including "luck") or other people and not contigent on behavior, as in a respondent conditioning paradigm. Rotter's IE variable, and associated research and theory will be the primary point of departure for our review because it offers the greatest body of directly relevant data and methodology to draw from. However, other investigators have conceptualized phenomena similar to Rotter's IE variable in quite different ways. Solomon and others, in their research on "conditioned helplessness" in dogs (see Maier, Seligman, & Solomon, 1969), conceptualized these phenomena in S-R learning theory terminology pertinent to the mediation of instrumental learning. Both Logan's (1960) and Spence's (1960) S-R treatments of instrumental learning touch on the contingency of the "anticipation" of reinforcement to specific instrumental responses, as do McClelland's (McCelland, Atkinson, Clark, & Lowell, 1953) and Atkinson's(1964) motivation theories. Although the major purpose of the present research is not to clarify the mediating processes and contingencies associated with these phenomena, it should make some contribution toward that end.

The Nature of IE

Whether IE should be considered a "cognitive" or "motivational" variable is a moot point. The question hinges partly on semantics, partly on pragmatics. In strict S-R terminology, any expectancy-type variable would be considered cognitive. In current common educational terminology, however, "cognitive" refers specifically to ability kinds of variables and would not include many expectancy variables. In motivational theory (e. g., Rotter, 1954), expectancy variables would ordinarily be referred to as cognitive, distinguishing them from reinforcement magnitude or need variables which would be called motivational. Historically, of course, the Tolmanian "cognitive maps" terminology clearly subsumes expectancy (or "expectation") variables under the cognitive category. Thus IE, as well as other expectancy-type variables, is clearly a cognitive variable within several theoretical frameworks and nonenclatures.

There is another more compelling argument, however, for considering IE as a cognitive variable. The acquisition of internal control expectancies represents a cognitive accomplishment, a cognitive ability (to see relationships) similar in many formal respects to language competence, mathematical comprehension, or Piagetian logical operations. Whether to call IE "cognitive" is confusing simply because the IE variable simultaneously has the most important properties of each of several ordinarily separate classes of variables - cognitive, motivational, stylistic, and attitudinal. It must be considered to have the essential characteristics of a cognitive accomplishment variable because it represents the child's learning of relationships of an abstract nature, which is the common element of every cognitive variable; and because the child acquires this knowledge or perception of relationships between reinforcements and his behaviors through development and experiences in the same way as, presumably, all cognitive accomplishments are acquired. In other words, internal control expectancies are learned. This issue is sometimes overlooked because of the confusing fact that the child can also learn inappropriate or incorrect internal expectancies - e.g., "When I think bad thoughts, my memory gets sick." However, inappropriate relationships are also learned in the language, mathematical, and logical thinking domains.

It is true that IE has the distinctive characteristics of stylistic variables, as illustrated by evidence of IE differences in the use of repression, rationalization and goal-setting behavior. It also has the characteristics of motivational variables as illustrated best by IE differences in activity and vocational preferences. Finally, it has some characteristics of attitudinal variables as seen in the manifest content of many IE expectancies as expressed in IE items. The convergence of the central properties of so many ordinarily separate classes of variables is exactly what makes IE a unique and potentially powerful focus of inquiry. It does not, however, make it in any affirmative sense less of a cognitive variable.

Socio-economic Status, Parential Factors, School Achievement, and IE

Several independent studies have confirmed Coleman's finding of socio-economic differences in IE. Battle and Rotter (1963) did one of the earliest studies comparing Negro and White children of differing socio-economic status. They used the Bialer-Cromwell Locus of Control Scale as well as a projective test consisting of six cartoons as their measures of internal-external control. Their results with sixth and eighth grade children showed that middle-class whites were internally controlled while lower-class Negroes were more externally controlled. This finding has been confirmed with eighth and eleventh grade Negro and White children (Lessing, 1969) and with adults (Lefcourt and Ladwig, 1965). Shaw and Uhl (1969), however, found that white upper-middle class second graders were significantly less external than middle-class Negro or lower-class Negro and White second graders. They also used the Bialer-Cromwell Scale. Wolomon, Houlihan, and Perelius (1969), using the Intellectual Achievement Responsibility questionnaire (Crandall, Katkovsky, and Crandall, 1965) as their measure of IE, matched fourth and sixth grade Negro children by parental occupational with white children of the same grades. They found no differences attributable to race although girls scored higher than boys in internal responsibility scores.

These findings are typical of those studies in the literature comparing black and white children from differing socio-economic levels. Generally, they indicate that children from the lower socio-economic level are markedly more external than children from the middle socio-economic level while no clear differences between black and white children are evident when socio-economic level is controlled.

Since socio-economic level is not in itself a psychological variable, one can only speculate on the factors responsible for this difference in IE between levels. One clue comes from the studies done by Katkovsky, Crandall, and Good (1967) and Davis and Phares (1969). In these studies an attempt was made to determine parental antecedents of children's belief in: internal-external control of reinforcements. Katkovsky, et. al., found significant positive relationships between a child's, especially a male child's, internal locus of control and a mother's protectiveness, approval, and affection. They also found for both sexes, that positive reactions by fathers were associated with the child's, especially female child's, internalness while negative reactions by fathers were associated with the child's, especially female child's, internalness while negative reactions by fathers were associated with externalness. The results of the Davis and Phares study were less relevant but they reported a tendency for fathers of internals to be more indulgent and less protective than fathers of externals. Thus, the socio-economic differences in IE may be at least partially due to the fact that children from the lower socio-economic level have mothers who are less protecting, approving, and affectionate as well as fathers who react more negatively to them and are less indulgent of them. Although it is tempting to speculate further on the reasons for IE differences between socio-economic levels (e. g., less consistency among lower-class parents in administering positive or negative reinforcements, less verbalizing of the contingencies between the child's behavior and the reward or punishment he receives in lower-class homes, less real control over what happens to him, etc.), the empirical evidence is simply not yet available to allow one to draw definite conclusions.

Whatever the reasons for socio-economic differences in IE expectancies there is good evidence that the external control orientation of the lower-class child is related to poor achievement in school and school-like tasks. Butterfield (1964) and Stephens (1969) have demonstrated this with college students while McGhee and Crandall (1968) and Shaw and Uhl (1969) have demonstrated it with elementary school aged children. McGhee and Crandall tested 923 children and found that those having high grades were significantly more internally controlled than those having low grades. However; no significant relationships were found between IE and achievement test scores. Shaw and Uhl showed that internal control was associated with high reading scores on the Stanford Achievement Test in white, middle-class children. However, this relationship did not hold up for lower-class or Negro children.

Thus, the identification of children with external control orientations in the elementary schools is very important. Programs could be developed based on behavior modification principles to strengthen the externally oriented child's perceptions of the contingencies between his behaviors and the reinforcements he receives. Since culturally disadvantaged children seem to be preponderantly externally oriented, and because the home circumstances that have shaped them to be so will probably continue to exist, it is especially important that these children be identified and helped toward increasing internal controls.

Analytic Disposition

While locus of control has been alternatively considered a motivational and/or a cognitive variable, analytic disposition has been seen more singly as a cognitive style. The concept of analytic disposition as an important variable to consider in problem solving has arisen primarily from the work of Jerome Kagan (1966). Many American investigators have been interested in cognitive structures and how they develop, but Kagan's work is unique in that he has focused on two aspects of information processing that are intimately involved in the *initial* classification phase of problem solving. It is during this phase that external information is given its first symbolic coding and that the best possible solution sequence is selected.

More specifically, the two aspects of information processing that Kagan has identified are (1) the degree of reflection attendant upon classification and hypothesis selection and (2) the differences in the degree of stimulus analysis that precedes initial coding. The evidence available thus far supports Kagan's contention that these are two stable dimensions along which children and adults are distributed. The first dimension is called *reflection-impulsivity* and describes the degree to which the child reflects upon alternative classifications of a stimulus or alternative solution hypotheses in situations in which many response alternatives (i. e., classifications or solution hypotheses) are available simultaneously. Kagan has found that some children in these situations have a fast "conceptual tempo". They impulsively report the first classification that occurs to them or carry out the first solution sequence that seems appropriate. On the other hand, reflective children typically delay before reporting a classification or carrying out a solution hypothesis. They actively consider the available alternatives and compare their validity. The second dimension is called *visual analysis* and describes the child's tendency to analyze complex stimuli into their component parts. While some children fractionate a stimulus into small subunits, others label and react to a larger stimulus chunk.

There is more information at present on the stability and significance of the reflection-impulsivity dimension than there is on the variable of visual analysis. Reflection-impulsivity has shown generality over tasks, stability over time, and appears to be relatively independent of verbal skills. However, the results of a good many investigations (cf. Kagan, Moss, and Sigel 1963) indicate that spontaneous analytic concepts are the product of the joint action of the two more fundamental variables of reflection and visual analysis. If a child is to produce an analytic concept he must suppress the initially strong, culturally popular associations to a given stimulus presentation and reflect on alternative groupings. In addition, he must manifest a disposition favoring visual analysis.

The importance of analytic disposition for adequate performance in the elementary schools is brought home forcibly by Kagan's (1966, p. 517) statement that "Much of a child's academic activity in grades 1-4 involves accurate perceptual classifications. The child must discriminate *bag* from *bug*, *ear* from *eat* when he is learning to read. The second- and third-grader must note the difference between *99* and *69*, between 71 and 17, between x and ÷. It is not unreasonable to conclude that, aside from the acknowledged role of verbal skills, the child's positions on the reflection and visual-analysis dimensions are of considerable relevance for the mastery of basic language and numerical skills in the early school years."

There is a consistent cluster of characteristics impressionistically reported by investigators of analytic concepts in 7- to 10-year old boys (Kagan, Moss, and Sigel, 1963; Lee Kagan, and Rabson, 1963, and Kagan and Rosman, 1964). These boys were reported to be less distractible in the classroom, less likely to display task-irrelevant gross motor behavior on the playground or in a restrictive laboratory setting, and less likely to report many incorrect solutions. They were also more likely to become involved in sedentary tasks requiring long periods of concentration, more likely to prefer intellectual vocations that required motoric passivity (e. g., scientist, writer) and typically produced more complete drawings of objects. In general, young boys who prefer analytic conepts are more capable of sustained attention to visual inputs than less analytic youngsters.

There is some evidence that children from various socio-economic levels differ along the reflection-impulsivity dimension. Comparing culturally disadvantaged and advantaged children ranging in age from 4 years, 8 months to 5 years, 8 months, Mumbauer and Miller (1969) found that disadvantaged children were more impulsive in response style while advantaged children were more efficient in intellectual performance and paired associates learning. Zucker and Stricker (1968) compared lower-class Negro and middle-class White children of preschool age on a task designed to measure perceptual tempo. They found that the lower-class Negroes had shorter latencies of response. However, Coyle (1967) found that Negro children were more reflective, had significantly longer latencies, made fewer errors, and more correct responses on the first trial of a perceptual classification task than did White children when Negro and White children *were matched* for socio-economic level by parental occupation. As in the Mumbauer and Miller study and the Zucker and Stricker study, however, culturally disadvantaged children made significantly more errors and had fewer correct responses on the first trial than middle-class children.

Other correlates of reflection-impulsivity reported in the literature are sex (Zucker and Stricker, 1968), boys being more reflective than girls; age (Kagan, 1966), reflectivity increasing monotionically with age from grades 1-4; restlessness and autonomic correlates (Kagan, Rosman, Dag, Albert, and Phillips, 1964; and Kagan and Rosman, 1964), reflective children having lower variability in respiratory rhythm and greater cardiac deceleration when asked to attend to external stimuli; creativity (Ward, 1966), reflectivity being positively correlated with creativity; psycholinguistic abilities (Gentile, 1968), impulsive boys scoring lower on the Auditory-Vocal Association and Auditory-Vocal Automatic subtests of the ITPA; and eye movements (Drake, 1970), reflective children making twice as many comparisons among visually presented stimuli as impulsive children.

Since reflectivity appears to be associated with the ability to sustain attention and with better performance in problem solving, several investigators have successfully attempted to modify an impulsive conceptual tempo by various procedures. Kagan, Pearson, and Welch (1966) were successful in modifying impulsive styles of responding by simply suggesting to impulsive children that they were like an experimenter who always thought before answering. Similarly, Nelson (1969) was able to influence impulsive children in the direction of more observing responses on a perceptual task by suggesting a match-to-sample reflective strategy on a perceptual comparison task. Briggs (1968) reinforced response latency in middle-class youngsters and was able to increase or decrease latency by his procedure. These studies suggest that the fast conceptual tempo of impuslive children can be altered toward a more reflective style of responding.

Although less research has been done on visual analysis, several correlates of this aspect of analytic disposition have been found. Kagan, Rosman, Day, Albert, and Phillips (1964) found a strong correlation between visual analysis and analytic conepts and a tendency to analyze geometric stimuli into distinctive components. They also found visual analysis to be independent of reflectivity. Lee, Kagan, and Rabsen (1963) demonstrated that children who produced a larger number of analytic concepts manifested earlier acquisition of concepts requiring visual analysis (e.g., concepts such as "objects with missing leg" and "objects with a black band around them") in a standard concept formation task. However, the analytic children did not show earlier acquisition of concepts that did not require visual analysis. In another important study, Kagan, Moss, and Sigel (1963) found that analytic subjects recalled conceptually related words while non-analytic subjects recalled functionally related words in a serial learning task. In addition, highly analytic fourth graders responded to less salient parts of a geometric design.

Finally, analytic dispositions have been shown to have considerable stability in quite young children (Kagan, 1967) and in third-graders (Kagan, Moss, and Sigel, 1963). The stability of analytic dispositions was especially great over a one year period among girls in the third grade. Further, Kagan, Rosman, Day, Albert, and Phillips (1964) found the reflective-impulsivity dimension to be quite stable over a one year period in third and fourth graders.

In summary, the response style of analytic disposition is a product of the joint action of the two fundamental variables of reflection-impulsivity and visual analysis. These two dimensions are remarkably stable over time in infants, elementary school-aged children, and adults. Reliable procedures for measuring the position of children along these two dimensions, as well as measures of the more global analytic disposition itself, have been developed by Kagan. Although little work has been done in comparing culturally disadvantaged with advantaged children on these variables, there is evidence that culturally disadvantaged children tend to be more impulsive than reflective in response style. Finally, it is very encouraging to note that the impulsive conceptual tempos can apparently be readily modified. Considering the importance of analytic dispositions for problem solving, compensatory programs for culturally disadvantaged children should certainly include training toward increased reflection and visual analysis.

An Annotated Bibliography of
Selected References Covering
the Measurement of Cognitive Development
in Elementary School Children

This annotated bibliography contains the references judged most crucial to the task of measuring the cognitive development of children. Emphasis was placed on empirical studies which shed light on differential development among Negro, White and Spanish-American children and the problems of measuring cognitive development among culturally disadvantaged children.

As in the case of the literature review, the annotated bibliography is organized into five sections corresponding to the sections of the literature review.

Concept Formation
Annotated Bibliography

Becker, J. T. The effect of group administration of selected individual tests of language, visual perception and auditory perception by kindergarten, first-, second-, and third-grade children. Unpublished Doctoral Dissertation: Catholic University, 1969.

No significant differences were found between individual and groups scores on selected psycho-educational instruments. Subjects were 169 kindergarten, first-, second-, and third grade subjects. This study lends support for the use of group testing of elementary school children on cognitive variables.

Berg, E. A. A simple objective technique for measuring flexibility in thinking. Journal of General Psychology, 1948, 39, 15-22.

The test materials consisted of a pack of 60 response cards each containing from one to four identical figures of a single color. The figures were stars, crosses, triangles, and circles, and the colors used were red, yellow, blue, and green. Each could be sorted by the number, form, or color of the figures. There were four stimulus cards; first, one red triangle; second, two green stars; third, three yellow crosses; fourth, four blue circles. Reproduction of these cards appeared in the response pack and three of the response cards were duplicated.

The four stimulus cards were placed before the subject from left to right in the order given above. The subject was to sort the packet of response cards into four groups under the stimulus cards after which he was told whether he was right or wrong.

Blackwell, A. A. The development of concept formation in children. Dissertation Abstracts, 1962, 23, 1416.

The study, based on Piagetian theory, focused on (1) changes in the mode of approach to a task of concept formation as a function of developmental levels and (2) developmental differences in concept formation as a response to variation in material. The subjects consisted of 70 children, ten in each of seven age groups. The subjects were tested individually with sets of material which was a modification of an instrument reported by Bruner, Goodnow, and Austin. Form I consisted of an array of geometric figures, composed of a combination of four attributes, each varying in two ways. Form II paralleled Form I except that human figures were used.

The results indicated that (1) the mean number of choices required to attain a concept is an inverse function of age, (2) the mean number of attribute changes is an inverse function of age, (3) the mean number of choices more like the original focus card than like any preceding card choice is an inverse function of age, and (4) the mean number of redundant choices is also an inverse function of age.

Braun, J. S. Relation between concept formation ability & reading achievement at three developmental levels. Child Development, 1963, 34, 675-682.

The study hypothesized that (1) there is a positive relationship between concept formation ability and reading achievement in 3rd, 5th, and 7th grade boys, (2) the magnitude of the relationship is greater than that between reading and intelligence, (3) the concept formation - reading relationship increases significantly with age, and (4) overachievers in reading perform significantly better than underachievers on a concept formation test. The subjects consisted of 50 3rd grade boys, 50 5th grade boys, and 39 7th grade boys. These were "normal" groups. Underachievers and overachievers were selected on the basis of expectancy determined by MA.

All subjects were given a concept formation ability test which was adapted from materials developed by Reed. The test was individually administered and consisted of 20 concepts with six cards per concept. On each 3 x 5 card four words were typed in a horizontal line, each card having one word that had something in common with one word on each of the other cards. Subjects had to name the common concept.

Results indicated that all hypotheses were valid except hypothesis (2) at the third grade level.

Bryant, P. E. The transfer of sorting concepts by moderately retarded children. American Journal of Mental Deficiency, 1965, 70, 291-300.

The study consisted of two experiments on the transfer of learning by 40 retarded subjects whose ages ranged from 10 to 17 years and whose IQ range was 30-56. In both experiments the task was to sort cards differing in two dimensions on the basis of one dimension, size or shape. The first experiment investigated the effect of initial task instruction on transfer and the second experiment tested the ease with which positive and negative learning could be transferred. No significant differences were found in either experiment.

Charlesworth, W. R. The role of surprise in cognitive development. In D. Elkind & J. Flavell (Eds.), Studies in cognitive gorwth. New York: Oxford University Press, 1969.

A theoretical paper linking surprise and cognitive development. The author suggest that the study of neurophysiological processes. The organism's orienting reflex is identified as the most promising process for study. The GSR is suggested for use in studying cognitive development. GSR responses can be measured under conditions where a particular concept would lead S to expect an occurrence. If this occurrence fails to materialize then surprise will be registered, thus indicating the child has the concept.

Delacy, E. A. Some problems associated with a paper & pencil test of conservation of length. Child Development, 1967, 38, No. 3, 869-875.

A group form of Piaget's length conservation task was tested with 140 children aged 6-12 years with 10 boys and 10 girls at each age level. The subjects were tested individually. Two three-inch reference lines were given on cardboard and the subject was given paper to see if the lines were equal. Next, four plastic sheets of Mueller-Lyon illusion arrowheads (45°, 55°, 65°, 75°) were used, one at a time, to distort the equality. There was no difference in the degree of illusion created by the various arrowheads. The subjects could not reliably conserve length with this test until 12 years old. Some inversion of performance as noted for the ten-year-olds and this was explained in terms of shift from iconic to symbolic reasoning.

Farnham-Diggory, S. Cognitive synthesis in Negro and White children. Research Relating to Children, 1969, No. 23, 17-18.

The study experimentally analyzed the ability to integrate information when "triggered" by symbolic cues in three types of situations: verbal-integrating actions with logographs, maplike-integrating spatial ideas, and mathematical. The subjects were 212 Negro and White children aged 4 to 9 years.

A normative study was made of the effects of age, sex, race, and socioeconomic status on the three kinds of synthesis. A training study, utilizing Negro ghetto subjects only, assessed effects of four training conditions on verbal synthesis in 5-year olds; three training conditions on maplike synthesis in 7-year olds; and two training conditions on mathematical (ordering) synthesis in 4-year olds.

The results indicate that, in general, Negro children have special difficulty with spatial and mathematical synthesis, but are superior in verbal-action synthesis in comparison to white children.

Farnham-Diggory, S., & Bermon, M. Verbal compensation, cognitive synthesis, and conservation. Merrill-Palmer Quarterly, 1968, 14, No. 3, 215-227.

The study attempted to determine (1) if there is, as a correlate of nonconservation or preconservation responses, any evidence of coordinate information processing and (2) if children experiencing such difficulties fall back on a kind of serial processing. The subjects utilized were 26 K through 3rd graders from a public school serving a predominantly blue collar district. The mean ages of the subjects were 6.42 for 13 nonconservers and 7.78 for 13 conservers (conservation of liquids).

Two tasks were used. Task 1 used cardboard "cuffs" presented in pairs that differed in just one or two dimensions. Subjects were asked to verbalize how they differed. In task 2, subjects taught logographs were given two or three word sentences in logographs and asked to do it (jump over a block).

Results indicate that nonconservers may not be verbally coding the stimulus aspects critical to the conservation response and that nonconservers cannot synthesize as can conservers.

Fletcher, R. F. An investigation of the effect of an operationally - defined word on conservation of number responses. Dissertation Abstracts, 1967, 28, No. 3, 1223-B.

The study investigated the extent to which language is a factor in conservation of number. The subjects were 200 first graders. Responses to traditional conservation of number questions and questions employing an operationally-defined coined word "bimates" were compared. Subjects first received training in the meaning of "bimates." The test consisted of seven equivalent and seven non-equivalent sets of conservation of number problems. The test employed 14 separate devices. Group I subjects were asked "Is this bimates?" Group two was asked "Do we have the same number of red cards and blue cards?"

Results from each test indicated that language plays a part in the conservation problem, but in no test were there significant differences between responses to questions phrased in the two ways.

Freyberg, P. S. Concept development in Piagetian terms in relation to school attainment. Journal of Educational Psychology, 1966, 57, No. 3, 164-168.

This two year longitudinal study investigated the relationship between level of concept development and school attainment in arithmetical computation skills, in solving arithmetical problems, and in the verbal field in spelling. The subjects were 151 children aged 6 to 9 years in a New England city of 42,000.

A 72 item objective test of concept development was first devised and evaluated. The attainment tests were a 120 item arithmetic computation test, a 25 item arithmetic problem solving test, a 22 item spelling test, and a PMA intelligence test.

The study indicated that concept development is more closely linked to growth of general intellectual ability than to CA alone. It also suggested that school performance appears to be associated with aspects of conceptual thinking not adequately assessed by conventional intelligence tests.

Gilbert, L. E. An introduction of length concepts to kindergarten children. Technical Report No. 102. The Wisconsin Research and Development Center for Cognitive Learning. Madison: University of Wisconsin, 1969.

The study investigated the understanding of the terms generally used in the questioning procedure in Piagetian assessment of length conservation. Three rural kindergarten classes comprised of 71 white students served as subjects. Seventy of the subjects ranged in age from (5; 2) to (6: 3). Three experimental groups were formed by random assignment. One group received pretest, training, and posttest; one group received training and posttest; one group received pre- and posttest.

The three 20 minute training sessions focused on properties of length, comparisons of lengths, and representing length. Pre- and posttests were identical and individually administered. The tests consisted of twelve items, some Piagetian and others which involved materials to be manipulated by the subjects. The Piagetian items used rods, straws, line drawings or lines of plastic pegs.

Goldschmid, M. L., & Bentler, P. M. Dimensions and measurement of conservation. Child Development, 1968, 39, No. 3, 787-802.

A large pool of behavior and explanation conservation items on six tasks were administered to 143 kindergarten, first-, and second-grade children. Two parallel forms were developed and an additional scale assessing a different dimension of conservation was constructed. The scales were corss-validated on a new sample of 107 children. The study attempted to produce psychometrically sound conservation scales for educational and research uses.

Golledge, M. R. The development of Piaget-type formal & concrete reasoning. Dissertation Abstracts, 1966, 27, No. 3, 673-A.

The study tested the Piagetian view that concrete reasoning is mastered at about 11 years of age and formal reasoning at about 16 or 17 years of age.

Formal and concrete reasoning problems were given to 150 students in one Iowa school. Then, using a procedure involving McCall's T, 14 pairs of items were selected and administered to five groups of subjects in grades 5-9 in a second Iowa school. The items were arranged so that difference scores could be calculated for each pair. It was found that many subjects below age 16 had not mastered either type of reasoning and that scores improved with age. It was concluded that equilibrium had not been reached for either type of reasoning although concrete reasoning scores began to level off after year 12. Formal scores progressed in a manner consistent with Piaget's theory. It was suggested that reasoning development appears to be continuous rather than in a series of distinct stages.

Halpin, V. G. The performance of mentally retarded children on the Weigl-Goldstein-Scheerer color form sorting test. *American Journal of Mental Deficiency*, 1958, *62*, 916-919.

The study investigated eight questions having to do with the existence of a significant association between specific forms of color sorting behavior and CA or MA.

The subjects were 186 boys and girls aged 7-14 with IQ's from 40 to 70. The test consisted of geometrically formed pieces being placed on a table and instructing the subjects to "Put with each other all the pieces which are alike." The test was given individually, following the Goldstein-Scheerer procedure. Ability to shift voluntarily from one sorting category to another and explanation of the principle used was noted. Subject preference for color versus form groupings and instances of the use of a pattern formation response on the first trial were also noted.

Results indicated that neither preference for categorization by form or color nor the use of a pattern formation response is associated with CA or MA. Subjects with higher CA or MA showed a greater tendency toward shifting and in the total sample color tended to be used more than form.

Hall, V. C., & Kingsley, R. Conservation & equilibration theory. *Journal of Genetic Psychology*, 1968, *113*, No. 2, 195-213.

Basic tenets of the equilibration theory explanation of conservation acquisition are presented. Conservation is then analyzed and its efficacy as a concept is questioned. In addition, methodological criticisms of the clinical probing technique typically used by conservation researchers are made and substantiated. It is shown that children in the stage of intuitive thought do not necessarily rely on visual cues but are quite dependent on experimenter suggestion, which is shown to bias the results systematically.

Four studies are reported. The first involved 40 subjects aged (5; 6) to (6; 2) and investigated the influence of methodological difficulties on weight and length. The second used tape-recorded verbal instructions to the same subjects. The third and fourth studies involved college students in psychology and learning who were given a group test, recording their responses on answer sheets.

Heald, J. E., & Margolf, S. S. Abstract behavior in elementary school children as measured by the Goldstein-Scheerer stick test and the Weigl-Goldstein-Scheerer color form sorting test. Journal of Clinical Psychology, 1953, 9, 59-62.

The Goldstein-Scheerer Stick Test and Weigl-Goldstein-Scheerer Color Form Sorting test were used to measure abstract behavior in 138 children in grades 1 through 5. The subjects were pretested for color vision anomalies.

The stick test is an individual test consisting of 20 plastic sticks of three different lengths. Half are given to the subject and half are retained by the examiner. The examiner makes each of 30 designs and after each the subject is to copy it. After completion of the 30 designs the process is repeated except that the design is given, withdrawn, and the subject is to do it from memory.

The CFS test consists of 12 plastic pieces; four each of squares, equilateral triangles, and circles which are red, yellow, blue, or green on one surface but white on all others. The subject is asked to sort the objects into groups which seem to go together. Then he is asked to "shift" from color to shape sorting.

Klugh, H. E., & Roehl, K. Developmental level & concept learning: Interaction of age & complexity. Psychonomic Science, 1965, 2, 385-386.

The study investigated the interaction effect between developmental level and problem complexity on trials to solution of a relational concept formation problem. Sixty elementary school children served as subjects. Age groups of the subjects were 3-6 years and 9-10 years.

The apparatus used was a modification of the Yerkes Problem Box which housed twelve evenly spaced levers. One of the bars could be selected so that when pushed by the subject a buzzer sounded signifying a correct choice. From four to nine adjacent levers were presented depending on problem complexity and the subject was told at the outset that there was a rule which would allow him to be correct on every trial (push the second bar from the right). The test was individually administered. Some subjects from both groups were unable to verbalize the concept even though they met a trials correct criterion.

Kofsky, E. A scalogram study of classificatory development. *Child Development*, 1966, *37*, No. 1, 191-204.

Eleven classification tasks were subjected to scalogram analysis. No clear cut evidence for a undimensional scale was found. Only 27% passed all items up to a point and then failed all others. Subjects were 122 children ages 4 to 9 years. Tasks were developed that required Ss to demonstrate their understanding of each of the 11 classificatory operations by correctly manipulating a set of geometric blocks. Tasks were administered individually in a random order.

Kugelmass, S., & Foundfur, M. R. Zaslow's test of concept formation: Reliability & validity. *Journal of Counsulting Psychology*, 1955, *19*, 227-229.

The study investigated the reliability and validity of Zaslow's Test of Concept Formation. The subjects consisted of 23 normal college students, 45 early stage schizophrenics and 23 state hospital patients (schizophrenics).

Zaslow's Test consists of 14 geometric designs on white 2 x 2 inch cards, forming a continuum of regular polygons from an equilateral triangle to a circle. Subjects are asked (1) to arrange a scattered display of the 14 cards in the best possible manner and (2) to arrange between the triangle and circle the 12 other cards in proper order. After (2) the subject is asked how many cards are in the triangle group and how many in the circle group. Finally the subject is asked to remove all cards which are in neither the triangle nor circle groups.

Using an analysis indicated by Zaslow, the test was seen to have low reliability and very questionable validity in distinguishing between normals and hospitalized schizophrenics seen early in hospitalization.

Maag, C. H. Development & evaluation of a concept reasoning test. *Educational & Psychological Measurement*, 1957, *17*, 230-239.

The test materials consisted of 32 small wooden blocks having 5 dichotomous characteristics, large-small, tall-short, round-square) hollow-solid, numbered-lettered. Test was administered individually to adults. E presented an exemplar of a two attribute class and S was to identify the seven correct members of the class from the remaining 31. S was told whether he was correct or not on each selection. Test was scored by counting the number of errors and recording the time to completion. Test was used for subjects in a stressful situation by having subject learn the task to criterion under normal conditions and retest under stress to determine effects.

Maltz, H. E. Ontogenetic change in the meaning of concepts as measured by the semantic differential. Child Development, 1963, 34, 667-674.

A modified form of semantic differential was given to subjects from 4 age levels: 2nd, 4th, 6th grades, & college. The task consisted of 7 concepts being rated along 9 scales.

It was shown that the connotative meaning of the concepts changes with age in such a way that the change becomes more apparent as the age difference becomes greater. Also concluded that meaning of concepts is less consistent in the youngest children.

It was suggested that, although modification may be necessary, semantic differential is a useful & valid instrument for measuring the meaning of concepts to children.

Norman, C., & Rieber, M. Facilitation of concept formation in children by the use of color cues. Journal of Experimental Psychology, 1968, 76, 460-463.

The study utilized 100 children aged 6 to 11 years to investigate the learning of single alteration (SA) and double alteration (DA) concepts with and without the aid of color cues. SA was found to be an easier concept to learn than DA and color cues facilitated learning, particularly in the DA schedule. To determine whether subjects who learned with color cues responded to color or concept, color was made irrelevant.

Results showed that once the sequence of correct responses was established, a large proportion of subjects apparently discovered the more abstract principle and no longer depended on the facilitating color cues.

O'Bryan, K. G., & Boersma, F. J. Movie presentation of Piagetian tasks: A procedure for the assessment of conservation attainment. Oral Report: American Educational Research Association. Los Angeles, California, 1969.

The data indicates that Piagetian conservation tasks may be effectively presented on movie with taped instructions in a standardized form without apparently destroying accuracy of classification. Subjects were 80 grade one children.

Osler, S. F., & Fivel, M. W. Concept attainment I: The role of age & intelligence in concept attainment by induction. Journal of Experimental Psychology, 1961, 62, 1-8.

The effects of age and intelligence on concept attainment by induction were investigated. Subjects consisted of 60 children each in age groups 6, 10, and 14 and were divided equally into normal and high intelligence groups.

Two 3 inch hollow cubes were used with a stimulus card in a frame attached to each. The stimulus card not identified with the concept (bird, animal, living thing) differed from the card identified with the concept in the object belonging to the concept but was similar in all other respects. A marble was under the concept category cube. The task was to point to the cube containing the marble and the criterion was ten consecutive correct responses.

Results indicated that age and intelligence are associated with significant differences in errors to criterion and number of successful subjects. Frequency of "sudden" learners was a function of IQ but not of age and rank-order coefficients between MA and error scores were highly significant.

Pascal, G. R., & Jenkins, W. O. The Hunter-Pascal concept formation test: An experimental approach to the measurement of cortical capacity. Journal of Clinical Psychology, 1959, 15, 159-163.

The study used the Hunter-Pascal Concept Formation Test to measure cortical capacity in 500 subjects ranging in age from 4 months to 55 years. The subjects also had various cultural backgrounds.

The test consists of nine problems: (1) Immediate Reaction (2) Delayed Reaction 1 (short), (3) Delayed Reaction 2 (long), (4) Delayed Reaction 3 (single alteration cue), (5) Single Alteration, (6) Double Alteration, (7) Serial Reaction 1, (8) Serial Reaction 2, and (9) Serial Reaction 3. The criterion was two consecutive correct trials for each problem.

Results indicate that most of the variance during the first 66 months of life is due to CA. Little relationship between IQ and H-P Test performance was found within the normal IQ range. It was concluded that the test appears to estimate some aspect of cortical capacity not measured in the usual tests of intelligence.

Peisach, E. The relationship between language usage and the achievement of conservation. Dissertation Abstracts, 1967, 28, No. 6, 2612-B.

The study explored the relationship between the comprehension and use of dimensional terms and the achievement of conservation.

Subjects for the study were 180 New York City public school children equally distributed by sex. The subjects were in SES levels I and III and grade levels K, 1, and 2. Tasks were given to evaluate receptive comprehension, expressive use of dimensional language, and ability to conserve.

Results indicated that comprehension of single dimensional terms was related to conservation at all three grade levels. Ability to verbalize how sets of objects were the same and the quality of dimensional descriptions of how sets differed were related to conservation in K and grade two and the verbal ability was related to conservation in grade 1.

Phillips, D. G. An investigation of possible hierarchical dependency of four Piaget-type tasks under two methods of presentation to third-, fifth-, & seventh-grade children. Dissertation Abstracts, 1968, 28, No. 7, 2564-A.

The purpose of the study was to investigate a portion of a proposed model for the acquisition of the concept of volume displacement and to compare two methods of conservation task presentation. The proposed model was a result of a pilot study.

Subjects for the study were 40 students from each of 3rd, 5th, and 7th grades in Tallahassee, Florida. All subjects were given the same tasks in individual interviews but each subject was assigned randomly to either an "object" presentation or a "graphic" presentation.

Results of a scalogram analysis of task scores supported the conclusion that the tasks used in the study were attained in the sequential order predicted by the model. There were significant differences in task attainment by grade level but not between the two methods of presentation.

Piaget, J., & Inhelder, B. *The psychology of the child*. New York: Basic Books, 1969.

This book is a summary of work of the Geneva Group. It deals with mental growth up to adolescence, the transitional phase marking the entrance of the individual into adult society. The work is written primarily from the point of view of genetic psychology rather than child psychology. It is divided into six major sections: the sensori-motor level, the development of the concrete operations of thought and the interpersonal relations, the pre-adolescent and the propositional operations, and factors in mental development.

Pinard, A., & Laurendeau, M. A scale of mental development based on the theory of Piaget: Description of a project. *Journal of Research in Science Teaching*, 1964, *2*, 253-260.

An attempt was made in this study to develop an ordinal scale of mental development an consequently a standardized intelligence test. Piaget's clinical method was incorporated. In a basic study, 700 subjects aged 2 to 11 years were individually tested.

Shantz, C. U. A developmental study of Piaget's theory of logical multiplication. *Merrill-Palmer Quarterly*, 1967, *13*, No. 2, 121-137.

Piaget hypothesizes that multiplication of classes, of logical relations, and of spatial relations are closely related from ages 7 to 11. The present study, in contrast to previous research, tested the three multiplicative abilities in the same children (ages 7½, 9½ and 11½). Matrix-type tasks were used requiring classification on double attributes, seriation on two continuous dimensions, and location of objects on a rotated surface. Significant correlations were found among the three tasks for the younger two groups.

Siegelman, E., & Block, J. Two parallel scalable sets of Piagetian tasks. *Child Development*, 1969, *40*, No. 3, 951-956.

The data reported by Smedslund for his tests of concrete reasoning, given to 160 subjects aged 4 to 11 years, were submitted to scalogram analysis. When one item was dropped the remaining eight were found to constitute two parallel forms with satisfactory scalability as assessed by two scalogram indices. The two scales are functionally similar. In addition, the order of items on the two forms is in accord with the body of theory and research on the development of concrete operations.

Sigel, I. E. Developmental trends in the abstraction ability of children. Child Development, 1953, 24, 131-144.

Changes in abstraction ability during the elementary school period were investigated utilizing 60 lower middle class whites as subjects. There were 20 subjects each of age 7, 9, and 11 years.

Five tests were administered, each containing 24 familiar toy objects, pictures of these toys, and word names of the toys. Subjects were instructed to group the materials on the basis of similarity. Categories used by the examiner were perceptual, conceptual and miscellaneous.

Results indicated a decrease in perceptual classification of items and an increase in conceptual classifications with age. Nine and eleven year olds increased the use of miscellaneous groupings when asked to reduce the number of groupings.

Stewart, E. E. A factorial study of concept learning. Dissertation Abstracts, 1960, 20, 2895.

The study attempted to identify some common processes involved in concept learning and in paper and pencil performance of abilities in the domain of reasoning. The subjects consisted of 156 paid male undergraduate volunteers.

There were 32 paper and pencil tests, including 15 reasoning tests, and four concept learning tasks. The reasoning tests were comprised of series, analogies, classification, grouping, group-naming, syllogistic tests, and a modified maze test. The concept learning tasks required the subject to learn to classify stimuli into groups.

Factors identified were: A-perceptual representing predominantly perceptual speed, B-thought to represent flexibility in reasoning about non-verbal material and to a lesser extent verbal material of a concrete nature, C- a verbal relations factor, D- identified with Thurstone's second memory factor, and E- facility in paired-associates memorization.

Stone, D. R. Developmental aspects of three dimensional concept attainment. Psychonomic Science, 1968, 11, 343-344.

Subjects for the study were 360 students in grades 1 through 9. The task required the subject to place 54 blocks varying in color, size, and shape into a three-dimensional sorting bin containing 54 compartments. The three dimensions color, size, and form had to be taken into account simultaneously by the subjects.

Significant system differences began to appear at the sixth grade level, but overly "concrete" responses to selected attributes extended strongly into the ninth grade. It was found that discrimination training resulted in significantly increased scores.

Suppes, P., & Rosenthal-Hill, O. Concept formation by kindergarten children in a card sorting task. Journal of Experimental Child Psychology, 1968, 6, 212-230.

50 kindergarten children learned to sort cards according to one of 4 attributes on each of 3 dimensions. Geometrical cards had dimensions of shape (squares, triangles, circles, diamonds), border (striped, dotted, plain, filled with black ink), & color (red, blue, green, yellow). People cards depicted boys, girls, men, women who were sitting, running, walking, or standing, & wearing yellow hats, blue coats red scarves, or green jackets). For the first two sets of problems, information was presented to the subject by two positive exemplers. (Half the subjects had "geometric" problems first; half had "people" problems first). For both groups positive transfer occurred from the first set of problems to the second, but problems with "people" cards were more difficult than problems with "geometrical" cards. After reaching criterion on the first two sets of problems, subjects quickly mastered problems with a positive example & a negative one. An all-or-none model was found to be inadequate as a description of the learning process. Subjects achieved few correct solutions, however, before reaching criterion (4 out of 5 consecutive problems solved correctly for one dimension) and correct responses tended to occur in the last phase of the experiment.

Tagatz, G. E. Learning set and strategy interaction in concept learning. Journal of Educational Psychology, 1969, 60, 488-493.

The study investigated learning set and strategy interaction in concept learning using the Tagatz Information Processing Test (TIPT) and concept attainment tasks. Subjects consisted of 73 college sophomores.

The TIPT problems each contained an exemplar focus card plus an exemplar or non-exemplar. The subject was to determine inclusion, exclusion or indeterminateness of a third card's membership in a group with the focus card on the basis of this information.

The first and second concept attainment tasks were each composed of 20 problems containing an equal number of three- and four-attribute concepts to be identified by meansnof a stimulus display and commonality or conservative instructional strategy. Tests were given separately to groups in booklet form.

Tuddenham, R. D. Psychometricizing Piaget methode clinique. In I. J. Athey & Rubadeau (Eds.), *Educational implication of Piaget's theory*. Waltham: Ginn-Blasidell, 1970.

Author is attempting to develop a standardized intelligence test based on the theory of Piaget. They have centered attention on the transition from preoperational stage to stage of concrete operations.

Weiss, A. A. The Weigl-Goldstein-Scheerer color-form sorting test classification of performance. *Journal of Clinical Psychology*, 1964, *20*, 103-107.

The study investigated the relationship between level of performance on the Weigl-Goldstein-Scheerer Color-Form Sorting Test and age and intelligence. The subjects involved were 71 normal Jewish children whose ages ranged from (8;8) to (14;5).

The criteria used were shift, pattern formation, and level of explanation. An ordinal scale was devised to rate these criteria in performance on the WGS test. Results indicated a significant positive relationship between total level of performance, based on the three criteria, and age and intelligence. An abrupt improvement in performance was evident at age 12.

Wheeler, M. E., & Ginsburg, H. The effects of a motivating non-verbal assessment procedure on conservation responses. *Cornell Journal of Social Relations*, 1969, *4*, No. 1, 32-37.

The study investigates Piaget's explanation of failure to conserve discontinuous quantities. Piaget's explanation involves certiation. Alternative hypotheses attribute the failure to conserve either to poor linguistic ability or inadequate motivation. The study gives a direct comparison of the two points of view.

A non-verbal motivating assessment procedure, employing the legitimate non-conservation problem, failed to show greater success in 40 non-conserving four-year-olds (mean age 4-7) than a standardized version of Piaget's clinical method. Results were interpreted as supporting Piaget's position.

Youniss, J., & Furth, H. G. The role of language & experience on the use of logical symbols, *British Journal of Psychology*, 1967, *58*, 435-443.

Subjects for the study consisted of 24 deaf, 24 culturally deprived American Indian, and 24 middle-class control children aged 11 to 13 years. The subjects were given five daily non-verbal training sessions in identification of picture instances as true or false denotations of symbolic statements of eight logical concepts. On the fifth day the subjects were given a paper and pencil test on newly introduced instances of concept statements.

The deaf and Indian subjects showed a similar performance pattern across concepts which differed notably from that of the controls. It was concluded that the deaf and Indian subjects tend to depict attributes literally by use of symbols while the controls were better able to apply symbols as they represent classes of instances.

Yudin, L. W. Concept attainment & intelligence: A developmental study. Dissertation Abstracts, 1965, 26, 2330.

The subjects for the study were 36 males aged 12, 14, or 16 years who were divided into three groups by IQ. Only those with achievement commensurate with IQ were selected.

Subjects were shown 2" x 2" color slides and were presented with two instruction and six experimental concepts. Ten instances (each a single attribute) were presented for each concept.

Results indicated that the number of instances required decreases with age, the percentage of incompatible strategies decreases with age, the number of ideal and compatible strategies increases with age, IQ is significantly related to fewer instances to attain concepts, lower IQ is not significantly related to greater perceptual errors, and development of cognitive functions in adolescents of different IQ does not follow identical patterns nor become manifest at identical periods.

Language Development

Annotated Bibliography

There are three recently compiled annotated bibliographies which, when combined, form a reasonably comprehensive listing of relevant articles: 1) Office of Education. Language development in disadvantaged children: An annotated bibliography, 1968. Yeshiva University, New York, N. Y.: 2) Educational Testing Service. Research on the disadvantaged: An annotated list of relevant ETS studies, 1951-1969. Educational Testing Service, Princeton, N. J., 1969; 3) Williams, F., & Naremore, R. C. An annotated bibliography of journal articles. In Williams, F. (Ed.) Language and poverty: Perspectives on a theme. (Date on bibliography is June 1969.) Chicago: Markham Publishing Co., 1970. References below do not appear in the above.

Bailey, B. L. Language and learning styles of minority group children in the U.S. Research in Education, 1970, 5, 4.

The author comments on the linguistic behavior of Negro children concentrated in communities where non-standard forms of English are in wide use. She proposes that the non-standard dialects differ from standard English in a patterned way, and that every teacher should understand these linguistic differences if effective learning is to be accomplished.

Baratz, J. C. A bi-dialectal task for determining language proficiency in economically disadvantaged Negro children. Child Development, 1969, 40, 889-901.

Disadvantaged Negro and lower middle-class white children were administered a repetition task involving standard and non-standard English sentences. Results indicated that Negro children performed significantly better than white children on the non-standard stimuli. The converse was true for the standard sentences. The interaction of age and grammatical feature was also significant for both groups. The results of this research clearly indicate that there are two dialects involved in the educational complex of black children; that black children are generally not bi-dialectal; that there is evidence of interference from their dialect when black children attempt to use standard English; and that language assessment of disadvantaged Negro children must involve measures of their knowledge of non-standard English as well as additional measures of their knowledge of standard English.

Baratz, J. C. Should black children learn white dialect? *Asha*, 1970, *12*, 414-417.

The author argues for teaching the major American dialect to black children. She refers to a contrastive analysis approach presently being used at the Education Study Center in Washington, D. C.

Barclay, L. F. K. The comparative efficacies of Spanish, English and bilingual cognitive verbal instructions with Mexican-American Head Start children. *Research in Education*, 1969, *4*, 11.

Sixty-seven Mexican-American children in a Head Start program were subdivided into the following groups: 1) Spanish was used as the instructional language, 2) English was used as the instructional language, and 3) both English and Spanish were used as the instructional language. On the post-test array using a variety of measures, the bi-lingual instructional group was not shown to be superior to the English or Spanish instructional groups. The author adds that since there weren't controls on beginning ability the results are not conclusive.

Blanco, G. Texas report on education of bilingual students. *Research in Education*, 1968, *3*, 8.

A description is offered of nine elementary programs being used in Texas in the area of bi-lingualism. The programs range from all English to all Spanish, and include a beginning development of a statewide bi-lingual curriculum.

Brengelman, F. H., & Manning, J. C. A linguistic approach to the teaching of English as a foreign language to kindergarten pupils whose primary language is Spanish. Cooperative Research Report #2821. Fresno State College, 1966.

A linguistically-oriented language program was used with kindergarten Spanish-speaking children. Three aspects of the results are: 1) phonology, syntax and vocabulary of English can be taught through formal classroom procedures, 2) minimal English facility pupils are apt to make the most improvement, and 3) boys tend to respond more to phonology than girls.

Gonzales, E., & Plakas, J. Bilingual education for Mexican-American children--report of experiment for Marysville school *Research in Education*, 1968, *3*, 10.

An ungraded primary classroom of 8 boys and 11 girls of Mexican-American background was arranged for children whose age range would have placed them in the kindergarten through fourth grade. A bi-lingual program in math, science and social studies was offered. Favorable results are reported, however, no control group was included in the design.

Green, M. B. Improving the meaning vocabulary of inner city children. Research in Education, 1970, 5, 4.

Parents and teachers are encouraged to change the curriculum for inner-city children in the direction of increasing his vocabulary. Suggestions include reading to the child, talking to the child, playing word games, and taking trips. Also included are a sequence of specific word recognition skills at various grade levels and an Afro-American vocabulary list.

John, V., Horner, V., & Socolov, J. American voices. The Center Forum, 1969, 4, Pp. 1-3.

Evidence is presented for initial teaching in the child's primary dialect.

Johnson, K. R. Teaching culturally-disadvantaged pupils (Unit IV, Unit VII). Research in Education, 1969, 4, 10.

This is a Science Research Associates' program for improving the language abilities of minority group children. A position on language in the disadvantaged is offered with examples of points of interference between the child's primary code and standard English within a variety of disadvantaged minority group children.

Klaus, R. A., & Gray, S. W. The early training project for disadvantaged children: A report after five years. Monographs of the Society for Research in Child Development, 1968, 33, (Whole No. 4).

In a Head Start intervention program, gains have tended to be maintained at a significant level for four years. The gains, however, in the authors' words, are modest ones and the program has been relatively intensive. On the two tests of language, the PPVT and the ITPA, the experimentals were superior to the controls, although in the second year of public schooling the advantage on the ITPA was lost.

Kochman, T. "Rapping" in the black ghetto. Trans-action, Feb. 1969, 26-34.

Using examples from inner-city Chicago, this linguist insists that making it in the ghetto depends heavily on verbal ability and style in children and adults. He explains the verbal games of "shucking," "whupping" the game, playing the "Murphy" game, "running it down," as well as "signifying," "sounding" and "delivering toasts," and "playing the dozens." He compares and contrasts these verbal forms of behavior.

Labov, W. The logic of nonstandard English. In Alatis, J. E. (Ed.) *Monograph series on languages and linguistics*. Washington: Georgetown University Press, 1970.

The nonstandard forms of language which inner-city children exhibit are not random and illogical, they are patterned and follow the rules of any inherently consistent dialect. The linguistic behavior reported by Bereiter is merely the product of a defensive posture children adopt in an alien, threatening situation. There are many important questions concerning the cognitive correlates of syntactic complexity which current research technique has not yet answered. At present there is no basis for attributing poor educational performance to the grammatical and phonological characteristics of any nonstandard dialect of English.

Lance, D. A brief study of Spanish-English bilingualism: Final report, Research Project. *Research in Education*, 1970, *5*, 2.

There are five separate papers included in this report. Some of the conclusions are: nonstandard English usage of bilinguals is a result not only of the interference of Spanish but also problems in language development. Some dialect forms are common throughout the Anglo, Negro and Mexican-Americans of the same communities. Evidence indicates that when Mexican-Americans mix English and Spanish in the same sentence the result is not a creolized language, but a relaxed and arbitrary switching of codes.

Perales, A. M., & Howard, L. B. On teaching the disciplines to disadvantaged Mexican-Americans: A linguistic approach. *Research in Education*, 1970, *5*, 1.

These authors point out that traditional teaching methods are based on the assumption that all the children speak English as a mother tongue. This is not the case, and the disadvantaged child is particularly hurt in subjects that are taught in the lecture method, in which the teacher does most of the talking. These courses should be restructured so that a variety of audio-lingual techniques are utilized to provide maximum opportunities for the children to verbalize.

Rosen, C. L. Some needed research regarding the language and reading instructional problems of Spanish-speaking children. *Research in Education*, 1969, *4*, 12.

The author delineates needed areas of research in both oral language and reading for Spanish-speaking children. He believes that at present little valid information is available in linguistic descriptions of this subpopulation of children, let alone reliable methods of remediation.

Rystrum, R. The effects of standard dialect training on Negro first graders learning to read. Research in Education, 1969, 4, 10.

Two first-grade classes in Oakland, California, were divided into an experimental and a control group, the former being given special dialect lessons in standard English. Post-tests after eight weeks gave no support for the following three hypotheses: 1) that the children could be taught to use elements of English not in their dialect, 2) that such training would affect their reading scores in a positive manner, and 3) that such training would affect their scores in a favorable fashion on word-reading tests.

Silvarski, N. J., & Whitcomb, M. W. A comparison of the oral language patterns of three low socio-economic groups of pupils entering first grade. Research in Education, 1970, 5, 2.

Language patterns of low socio-economic Negro, Spanish surname, and Anglo children are sufficiently different to put them at a distinct educational disadvantage. Twenty randomly-selected first-graders from each ethnic group were interviewed and recorded at length as they told stories about pictures. The recordings were analyzed for both patterns and mazes (hesitations, false starts, etc.). On the basis of a simplified form of the Indiana Conference Scheme of Analysis, the three groups responded approximately the same on total sentence patterns and all specific sentence patterns, except one. They also responded approximately the same for the total number of mazes (tangles of language not effective in communication) and all specific mazes. The results were interpreted to mean that all the groups are aware of, and use, basic English syntax patterns in approximately the same manner. It is suggested that differentiated materials are not needed as much as exposure to total language developing experiences.

Smith, H. W., & May, W. T. Influence of the examiner on the ITPA scores of Negro children. Psychological Reports, 1967, 20, 409-502.

To establish local normative data for six-year-old Southern Negro children from low socio-economic backgrounds on the Illinois Test of Psycholinguistic Abilities, and to evaluate the effects of examiner differences, two Negro and four Caucasian examiners, with little but equal experience, tested 171 subjects. The overall language score in five subscales reflected significant examiner differences; thus, the normative value of the scores is questionable. (This is a 1967 reference, so presumably the more recent version of the ITPA was not used.)

Stewart, W. A. Toward a history of American Negro dialect. In Williams, F. (Ed.) Language and poverty: Perspectives on a theme. Chicago: Markham Publishing Co., 1970.

Present work in linguistics indicates that there is indeed a Negro dialect, and some of the forms of this dialect are relatively uniform throughout urban black communities.

Thomson, J. W. The implicit unit of linguistic analysis used by advantaged and disadvantaged children. Research in Education, 1969, 29, 8-A.

Three-element sequences drawn from speech samples of young, disadvantaged children were randomly assigned to three orders of presentation: syntactically correct, inverted, and scrambled. Eighteen advantaged and eighteen disadvantaged four-and-a-half, and five-and-a-half year olds were trained to a preset criterion on their ability to invert the noun and noun-verb sequences. No difference was found for social class, and no interaction of social class and order of presentation. The results were interpreted as support for the position that the sequential probabilities in the language are learned, and functions to inhibit the violation of normal word order, and facilitates the combination of words as syntactically correct sequences.

Wakefield, M. W. A comparative study of language patterns of low socio-economic first graders--Negro vs. Spanish vs. Anglo. Research in Education, 1969, 29, 4-A.

Stimulus pictures were used by an interviewer to elicit oral responses, which were recorded and transcribed, and subsequently analyzed for frequency of ten basic English sentence patterns and four types of mazes (interruptions, false starts, etc.). The analysis was based on the Indiana Conference Scheme of Analysis. The results indicated no significant differences in the overall oral language patterns or in the frequency or use of language mazes in any of the three subgroups of Negro, Spanish surname, Anglo first graders.

Logical Thinking
Annotated Bibliography

Deutsch, M. The role of social class in language development and cognition. American Journal of Orthopsychiatry, 1965, 35, 78-88.

The population studied included a core sample of 292 children from grades 1 & 5 and an extended population of about 2,500 children of various racial and social class groupings. Negro and white, lower-and middle class children were included in a relatively well-balanced sample. The complete study included over 100 variables concerned with home background, language functioning, conceptual behavior, intelligence, reading, and other related factors. This report refers to 52 variables concerned with a range of cognitive functions and a few demographic measures, but with an emphasis on language variables.

At the first grade level, lower SES was associated with poorer performance on all IQ scores, verbal identification, abstract conceptualizing of a visual stimulus, and a concept sorting test. If race is added to SES at 1st grade, concept formation and auditory discrimination are also affected. Race alone accounts for significant changes in six variables including verbal identification, concept sorting and concept formation.

At the fifth grade level, all IQ measures were influenced by both SES and race. Also correlated with SES in fifth grade were word association, concept formation and concept sorting (categorizing visual stimuli). Another related measure was a reading score. Correlating only with SES were abstract categorization of visual stimuli and manipulative and syntactcal control of language. Twelve variables correlated to both SES and race as oppossed to only 3 in first grade.

What was found was a deficiency based on class and race in the measures which reflect abstract and categorical use of language as opposed to denotative and labeling usage. The author concluded lower-class children, both Negro and White, are subject to a "cumulative deficit phenomenon" between 1st and 5th grade.

Dodwell, P. C. Relations between the understanding of the logic of classes and of cardinal number in children. Canadian Journal of Psychology, 1962, 16, 152-160.

This study investigated the relationship between the development of concepts of number and the ability to classify and to understand the logic of classes. Dodwell's classification test required the S's to respond to six situations in which they were presented with two groups of objects all of which belonged to one class. For example: garden tools as exemplified by 5 shovels and 6 rakes. The question to the S was "are there more rakes or more tools?"

The subjects were 60 children of average intelligence from grades K to 3 (ages 5.2 to 8.8). Testing was done individually.

Findings revealed three categories of classification which Dodwell compares to Piaget's three stages of number concept development, namely: global comparison, operational judgment and intuitive judgment. There was a low but significant correlation between ability to classify and a number concept test. (The latter is not described). Dowell concluded that the understanding of the nature of a hierarchical classification develops independently of the understanding of the concept of cardinal number, but that they both develop within the same age range.

Ennis, R. Conditional logic and primary children. Papger read at American Educational Research Association, Minneapolis, March, 1970.

Ennis employed a specially constructed Smith-Sturgeon Conditional Reasoning Test to assess the development and utilization of four elements of deductive logic as presented in "if-then" type questions. The four elements were: basic understanding, contraposition, conversion, and inversion. The test was administered individually, verbally and with concrete objects. The subjects involved were 180 children from grades 1, 2 and 3, divided into three groups according to their residence in rural, urban or suburban areas. Half of the S's served as a control group while the remainder were involved in an experiment to teach logic. The results of the latter were insignificant and the developmental data are based on the control group.

The results of the study indicate that many primary S's had already mastered some of the basic principles of conditional logic but performed poorly on questions involving contraposition. Levels of significance are not reported, however, the author states that there were high correlations between the test of conditional logic and measures of verbal intelligence, socioeconomic status and area of residence. There were no sex differences.

Furth, H. G., & Youniss, J. The influence of language and experience on discovery and use of logical symbols. British Journal of Psychology, 1965, 56, 381-390.

Two tasks were devised which required acquisition and utilization of certain logical principles by means of visual symbols. The symbol-use (SU) task required comprehension of the logical symbols for affirmation, negation, conjunction and exclusive disjunction in different symbolic expressions. The symbol discovery (SD) task required concept attainment in a discovery task. There were three groups of subjects. The deaf group was 40 boys and girls aged 16-20 and 27 boys and girls aged 12-14. The lower class group was 49 older pupils (mean CA = 17.4) and 56 younger pupils (mean CA = 13). The hearing control group was 26 naval recruits (mean CA = 18.5) and 309 pupils age 9-14.

The symbol-use task differentiated adults of higher and lower intelligence. Most subjects CA = 12 or older discovered the significance of logical symbols in the SD task. Symbol discovery and symbol use tasks were given to both deaf and lower-class subjects. These experimental groups performed about the same as the control groups on the symbol use tasks but did not attain the success of the 12-year old controls on the symbol discovery task. The author concludes that low socio-economic status may adversely affect logical thinking of the discovery type while more structured logical tasks are not adversely affected by low socio-economic status or linguistic deficiency.

Glasman, L. D. A social-class comparison of conceptual processes in children's free recall. Unpublished Doctoral Dissertation. University of California, Berkeley, 1968.

Subjects were tested in a free recall test using randomized lists of twenty items, divided into four categories. The stimuli were toys, not words, and recall was given orally. A word association test was also used in which the subjects were asked to list all exemplars they could think of for superordinate categories. Subjects were also asked to identify the unifying concept for each of the four groups of stimuli they had seen in the recall task. Finally, all subjects were given Peabody Picture Vocabulary Test, Form B.

There were 64 lower SES subjects and 64 upper SES subjects divided equally between kindergarten and fifth grade.

The results of an IQ analysis showed a mean difference at 30 points between SES groups. The other 3 tests showed SES differences between fifth-graders, but not kindergarteners. These three measures were shown by correlational analyses to be highly related to MA and IQ in fifth grade but not in kindergarten. The concept identification task found lower-SES kindergartners significantly inferior to the other three groups, but, high SES kindergartners could not use these concepts to any greater extent than their lower-SES peers to improve performance on other experimental tasks. The author suggested a theory of a qualitative difference in the cognitive functioning of pre-school and older children.

Heald, J. E., & Marzolf, S. S. Abstract behavior in elementary school children as measured by the Goldstein-Scheerer stick test & the Weigl-Goldstein-Scheerer color form sorting test. Journal of Clinical Psychology, 1953, 9, 59-62.

In a stick test, subjects were asked to reproduce 30 designs made by the examiner while looking at the design and also to reproduce the design from memory. The color-form sorting test required the subjects to group 12 plastic pieces either by color or form and then to regroup using another basis for grouping. The subjects were 72 boys and 66 girls ranging in age from six-years four months to 11 years three months.

The mean score for the entire group on the stick test was 28.7. The mean score increased with age but there was little difference between the scores of the youngest and oldest subjects.

On the color-form sorting test, all subjects made one sort, and 87% could shift the mode of sorting. At age 6, 71% could shift, while at age 10, 100% could shift. There were no significant sex differences.

Hill, S. A. A study of the logical abilities of children. Unpublished Doctoral Dissertation. Stanford University, 1961.

A 100 item test was given. Each item was in the form of a set of premises and a question about the conclusion to be answered yes or no. The test sampled from several parts of formal logic; sentential with both simple and compound tautalogical implications, classical syllogisms, and simple quantificational logic. The item content was verbal, using situations familiar to the children but not identical to their experiences. Content was fictional and hypothetical. Items were presented in 25 random schedules, individually, and except for one group, orally. Subjects were 270 elementary students aged 6, 7, and 8. There were 3 standard groups, one for each age; one reinforcement group, age six, which was corrected after each response; one baseline group, age six, which had one premise eliminated making logical derivation impossible; and one reading group which got a written test.

Children in age group 6-8 were able to a marked degree to recognize validity of logical inforces. The measure score for the standard groups was 78%. Scores increased with age for all categories and each principle inference, not in fixed stages but with gradual steady growth. There were differences in difficulty associated with types of inference, but they were also specific as to age. The reinforced group scored significantly higher than a standard matched group suggesting children can learn to recognize identical logical form in differing content. The addition of negation significantly increased the difficulty in recognizing validity. There were no significant differences due to sex or method of presentation.

Huttenlocher, J. Development of formal reasoning on concept formation problems. Child Development. 1964, 35, No. 4, 1233-1242.

This experiment dealt with the ability of children to solve concept problems involving binary attributes when presented with a variation in the sequencing of positive and negative instances of the desired attribute. The subjects were 300 children from grades 1, 3, 5, 7, 9, and 11. An equal number of males and females participated.

The testing procedure involved the use of a stimulus board which displayed an array of eight items which varied by color and shape. A bell and a light went on when a positive instance was presented. The subject was to determine what the criterion was for making the bell and light go on. Responses were recorded by the S's in booklets for each of the 24 items in the test.

Results of the experiment revealed that performance increased with chronological age and leveled off at ages 12½ - 13 or Piaget's stage of formal operations. The author suggests that children below the ages of 6½ - 7 cannot perform above chance levels on these items and that the growth of the ability to carry out a sequence of inferential steps in reasoning varies by age and by the number of steps required.

Inhelder, B., & Piaget, J. The growth of logical thinking from childhood to adolescence. An essay on the construction of formal operational structures, New York: Basic Books, 1958.

This was the first of the major works on logic and was originally published in French in 1955. It contains a comprehensive explanation, and discussion of Inhelder and Piaget's theory of the development of a mathematical-logical structure in childrens' thinking plus a description of the experiments which led them to their conclusions. As with many of their earlier works, this text suffers from a lack of information concerning subjects, sample sizes or statistical analyses. The work is extremely important however, for its contributions to this aspect of their theory of child development. Since the major emphasis is on the logical thinking abilities of older children, it ought to be consulted together with Inhelder and Piaget's later work on "The Early Growth of Logic".

Inhelder, B., & Piaget, J. The early growth of logic in the child. London: Routledge and Kegan Paul, 1964.

This is the second book concerning the growth of logical structures co-authored by Inhelder and Piaget. Originally published in French in 1959, the book differs markedly from its predecesor The Growth of Logical Thinking, in that it contains many tables and figures and reports sample sizes: a departure from the pattern established in earlier reports.

The book is a compendium of reports of numerous experiments designed to assess the growth of logical thought in pre-adolescent children, especially from the standpoint of their abilities to classify and to seriate. The experiments are described in detail and Inhelder and Piaget set forth their theory of psychological development in this area at some length.

Jackson, S. The growth of logical thinking in normal and subnormal children. *British Journal of Educational Psychology*, 1965, *35*, 255-258.

The subjects were individually tested at one sitting on 6 of Inhelder's experiments; conservation of motion, equilibrium in the balance, Falling bodies on an inclined plane, communicating vessels, the law of floating bodies, and oscillation of a pendulum. The interview was, a compromise between "clinical" and standardized. Upon completion of the experiments, each subject was tested on Raven's Progressive Matrices. Criteria for scoring was taken from Piaget and Inhelder's *Growth of Logical Thinking*. An overall sum of "logical thinking" was calculated and the results were plotted on Guttman-type scalograms. Rank correlations were calculated between logical thinking scores and chronological age (CA) and between logical thinking and Raven's matrices. Subjects were 48 children with IQ's between 90 and 110. There were 4 boys and 4 girls in each age group of 5, 7, 9, 11, 13, 15, and 40 children with IQ's between 60 and 80 with 4 boys and 4 girls in each age group 7, 9, 11, 13, 15.

The rank correlations were logical thinking and CA = +.608 and logical thinking and Ravens Matrices = +.859. Lower IQ children slowed little increase in scores past the age of nine. There were no significant sex differences. The author concluded that while responses generally followed Piaget's proposed levels of logical thinking, a wide variation in levels of logical thinking exists among children of similiar age. Further, the ability to think at a logical level in one situation does not necessarily imply the ability to think at that level in other situations.

Jacobs, P. I., & Vandeventer, M. The learning and transfer of double-classification skills by first-graders. *Research Bulletin*, Educational Testing Service, December, 1968.

A pretest was given to identify subjects who scored highest on a test of double-classification. These S's were then assigned to experimental or control groups. Experimental subjects were given pretraining in solving double-classification problems with stimuli varying in color and shape by the use of a 2 x 2 or 3 x 3 matrix task. Control subjects were engaged in an irrelevant task. In the training task, subjects were required to fill in an empty cell on the basis of form and color. To assess transfer, an eight-item test was constructed using a matrix involving size and shading (dots, stripes, etc). A second transfer test involving parts of Raven's colored progressive matrices was also used. The transfer tests were given immediately after training, and 4 months later. Subjects were 42 boys and girls divided randomly into experimental and control.

On first transfer test, the experimental group showed significantly more learning than the control group. On the second transfer test, the experimental group again performed significantly better than the control groups.

No significant changes occurred with regard to performance on Raven's Progressive Matrices.

Johnson, D. M., & O'Reilly, C. A. Concept attainment in children: Classifying and defining. Journal of Educational Psychology, 1964, 55, 71-74.

The test consisted of 54 cards, half with simple drawings of birds, the other half with corresponding descriptive verbal phrases of birds. Features of the birds varied three ways: wings were red, yellow, or blue; Tails were orange, green, or black; and beaks were short and pointed, long and pointed, or hooked. Subjects were to learn the difference between "gunkle" and "bunkle" birds. There were three groups of subjects; verbal, pictorial, and pictorial-definition. All were required to learn classification, but the pictorial-definition group was given practice at defining a rule of classification. The subjects were 60 children with average ability from ages 11-0 to 12-11.

The cards with verbal phrases were much easier to classify than corresponding picture cards. The verbal group gave many good definitions of classification but not significantly more than the pictorial group while the pictoral-definition group gave almost twice as many good definitions as the pictoral group.

Kofsky, E. A scalogram study of classificatory development. Child Development, 1966, 37, 191-204.

Working from Inhelder and Piaget's theory concerning the development of logic in children, Kofsky derived a hierarchy of eleven sequential steps which were translated into experimental procedures and administered to a sample of children in attempt to determine whether the predicted sequencing of items would prove valid. The eleven classifactory skills were identified as:

1. resemblance sorting
2. consistent sorting
3. exhaustive sorting
4. conservation
5. multiple class membership
6. horizontal reclassification
7. hierarchical classification
8. "some" and "all" relations
9. "the whole is a sum of its parts"
10. conservation of hierarchy
11. inclusion

The administration of the items involved the manipulation of sets of geometric blocks in individual testing situations.

The subjects consisted of 122 children of above average intelligence, ten boys and ten girls at each age level between 4 to 9 inclusive.

The results of the study indicated a significant correlation between age and performance on the tests, age and the number of tasks mastered and age and the scaling of the test items themselves. However, while the predicted sequence of difficulty of items was found to be correct, there was no set order of mastery such that the passage of a more difficult item invariable precluded the passage of all of the easier items. Hence, Kofsky concluded that individuals vary in the sequence of mastery of logical thinking tasks and the steps through which they attain perfection of any particular task. The results are discussed in terms of Inhelder and Piaget's theory and the work of other researchers.

Kofsky, E., & Osler, S. F. Free classification in children. Child Development, 1967, 38, No. 3, 927-937.

Two studies examined sorting behavior as a function of stimulus uncertainty, dimensional structure and component attributes of stimulus sets. The studies investigated the effects of age, number of stimuli, and number of stimulus dimensions upon ability to classify stimulus sets, ability to shift criteria after an initial classification, and the size of the class formed.

Three sets of geometric stimuli were used. The sets differed in form, color, number and size, although not all sets contained all four elements, Subjects were 72 caucasian lower-class boys equally divided among ages 5, 8 and 11. Subjects were individually tested. In the first experiment cards containing the stimuli were presented and the subjects were asked to group together cards that were the same, to describe the groups, to resort, describe, and resort and describe the groups again.

On the initial sort there was a significant difference between the adequate sorts produced by 5-year olds and older subjects. On the second sort there were significant differences between 5 and 8 year-olds and 8 and 11 year olds. Performance was not affected by the uncertainty and structure of sets. On resorts, flexibility in sorting increased with age. Five year olds selected color most frequently while the other 2 groups preferred form. Size was least preferential for all groups.

In the second experiment, the same sets of stimuli were used except that all groups contained form and color and subjects were simply to arrange stimuli into two groups. On this test, five year olds improved on initial sorting and more reclassifications were produced.

The authors concluded that children between 5 and 11 are able to sort into logical groups, that 5 year old children sort more poorly than older groups and have difficulty shifting criteria. All subjects had distinct attribute preferences, but these were more restrictive for the younger subjects. Uncertainty and structure seems to have little effect on frequency of adequate sorts and shifts. Most 5-year-olds were able to form consistent sorts and to form as large a group as older children but were primarily hampered by their inability to change criteria.

Lovell, K. A follow-up study of Inhelder and Piaget's The growth of logical thinking. British Journal of Psychology, 1961, 52, 143-153.

Two hundred average and bright subjects ranging in age from 8 to 32 years were tested on a number of experiments described by Inhelder and Piaget. Lovell replicated 10 of the original 15 experiments and each S was tested with a random selection of four of these. The tests used were: flexibility of rods, oscillation of a pendulum, falling bodies on an inclined plane, effects of invisible magnetism, combinations of colorless chemical bodies, conservation of motion on a horizontal plane, equilibrium in the hydralic press, equilibrium in the balance, projection of shadows, and correlations.

Each subject was tested individually using the Inhelder and Piaget procedures.

Results for each of the experiments are reported, the most important being that the major age-stage relationships which Inhelder and Piaget identified in the growth of logical thinking were confirmed with this sample. In addition it was noted that the least able subjects remain at a low level of logical thought development even at the age of 15. The author suggests that mental age rather than intelligence may correlate more highly with tests of logical thinking.

Lovell, K., Mitchell, B., & Everett, I. R. An experimental study of the growth of some logical structure. British Journal of Psychology, 1962, 53, 175-188.

This report concerns two series of experiments and a total of ten separate testing procedures. The testing situations involved (1) spontaneous classifications of geometric shapes and letters: additive classifications, (2) multiplicative classification, (3) anticipation and serial seriation, (4) multiplication of asymetrical transitive relations, (5) hierarchical classification of animals, (6) visual classification, (7) tactile-kinesthetic classification, (8) additive composition of classes involving marked perceptual differences, (9) a repetition of experiment 8 with different materials, (10) the use of the words "all" and "some" in situations involving color and weight.

The subjects for the first set of five experiments were 100 children, ten of average ability at each age from 5 to 10 inclusive and ten educationally subnormal subjects, ten at each age 9, 11, 13 and 15. The second set of five experiments was administered to a total of 100 subjects, 10 children of average ability at each age 5, 6, 8, and 9-11, and 25 subjects in each age group 10-13 and 14-15 in an educationally subnormal school.

The report discusses the results of each experiment in detail and compares the over-all findings with Piaget's theory of logical thought development. In general, the studies support his theory and indicated that the logical thinking capacity of educationally subnormal children falls considerably behind that of normal subjects.

Neimark, E. D., & Lewis, N. The development of logical problem solving strategies in children. Child Development, 1967, 38, No. 1, 107-117.

The problem was to develop a safe strategy for identifying a binary pattern concealed by a shuttered problem board. The subjects were 96 boys and girls between the ages of 9 and 14. Subjects were divided into normal (IQ = 90-117) and bright (IQ = 122-145) groups based on their performance on the California Mental Maturity Scale. Four additional groups of subjects were added, two groups at age 14 and one group each at ages 16 and 18. Following the identification task, all subjects were also given the Kagan Conceptual Style Test.

It was shown that younger subjects performed at essentially a random or nonlogical level and that performance increased with advancing mental age, with a steep increase in safe strategies around MA = 11. The correlation between a safe strategy and MA = .54 while the correlation between a safe strategy and IQ = .25. The correlation between a safe strategy and the Kagan CST = .16 while the correlation between the Kagan CST and MA = .15. Neither was significant at the .05 level.

The authors concluded that MA rather than IQ was the major factor in the development of a safe strategy and also suggested subjects may use a safe strategy before they can accurately describe it.

Nelson, W. N. Construct validation of the learning readiness system-seriation test. Unpublished Doctoral Dissertation, Indiana University, 1968.

Tests used were a seriation test developed by Scott, Nelson, and Dunbar; California Achievement Test; Primary Abilities Intelligence Test, and a teacher checklist of socioeconomic status. Seven small studies were designed. 1. Seriation training provided for 10 upper class children in kindergarten and their scores on seriation test compared with control group. 2. Seriation test given to 361 environmentally deprived Midwestern urban kindergartensis. 3. Seriation test given to 254 deprived and middle-class kindergartnsis. 4. After 2 years, all remaining 361 students in two of the original 4 schools given California Achievement Test and Primary Abilities Test. (N = 80) 5 & 6. Two classrooms of deprived kindergarten Ss were tested on seriation and one year later on Primary abilities. 7. A portion of earlier data of authors on race and seriation was retested after obtaining individual rather than total class socio-economic status, data from teacher checklists.

Ability of Seriation Test to predict academic and ability test scores over a two-year period ranged from .46 to .71. Higher correlations seemed associated with ability test. Seriation test seemed highly reliable and accurate and showed a close correspondence to reasoning factors in standardized tests. Socioeconomic class seemed to be a significant variable while race was not highly significant. Older children performed better on seriation tasks than younger children. Training resulted in predicted but non-significant gains.

Nowak, S. M. The development and analysis of the effects of an instructional program based on Piaget's theory of classification. Unpublished Doctoral Dissertation. State University of New York at Buffalo, 1969.

Subjects were trained in simple and hierarchical operations. One treatment group trained in both, and one treatment group only in the latter. Piaget's logical operations were transformed into a sequence of problem-solving tasks used in the training procedures. Classification materials included geometric forms and biological organisms. The classification subjects were 210 third graders and the subjects for assessing levels of classificatory across grade levels were 21 first-graders, 25 second-graders, and 29 third-graders. Subjects were also tested to relate the following variables to classification skills: IQ, reading, vocabulary, language, math concepts, problem-solving skills, and initial classificatory abilities.

A stepwise regression analysis showed prior classification experiences significantly related to categorizing skills, less related abilitys were general intelligence and math concepts. Children benefitted from 2 instructional sequences but the group receiving both types of training had significantly higher proficiencies in forming complete categories. While all three grades understood several concepts, third graders knew more concepts and a greater variety of skills. After training, girls achieved more skills pertinent to hierarchical classification.

Parker, R. K., & Halbrook, M. C. The utilization of concrete, functional and designative concepts in multiple classification. Florida State University, mimeographed, 1969.

A matrix task comprised of three pictures in a row and three pictures in a column meeting at a blank intersection was utilized to assess developmental changes in multiple classification. Three types of attributes were presented in the matrices: concrete (form, color, etc.), functional (common usage), and designative (belonging to a common class). Forty two items were contained in the matrix test.

The subjects were 80 children from an affiliated university school; 20 at each grade level, k to 3 inclusive (approximate ages 6-9 years). Testing was done individually and a practice period was incorporated into the procedures. S's were to choose one of three alternatives to complete the blank intersection of the matrix.

Results showed that performance improved with age and there was a significant interaction between grade and type of matrix. S's at age 6 performed well on concrete type matrices. The ability to use functional concepts increased with age to a peak in performance at age 8-9. The use of more abstract or designative concepts also increased with age and years of education. Comparison of results with Piaget's theory and the theoretical import of the findings are discussed in the report.

Price-Williams, D. R. Abstract and concrete modes of classification in a primitive society. British Journal of Educational Psychology, 1962, 32, 50-61.

A specially constructed test using models of familiar animals and actual plants from the area was used to assess bush childrens' ability to classify, sort and to shift classifications. The subjects were Nigerian children, 80 of whom were attending school and 60 who were illiterate. The S's were tested individually, in their language and were asked to classify the objects in as many ways as they could. Concrete classifications were considered to be those in which the s was thus unable to see it as representative of a class. Abstract classification was viewed as the ability to shift reflectively from one aspect of a classification to another and to form various groupings based on different criteria.

No differences were found between the two sets of children in their ability to classify, suggesting that growth towards the stage of concrete operations proceeds as a similar rate in both school and illiterate children. The older S's were able to make abstract classifications, however, the data indicates that there is a lag in this development for these subjects in comparison with the performance of European subjects.

Scott, R. et. al. Social-class, race, sex, and seriating: A study of their relationship at the kindergarten level. Research in Education, 1967, 4, 19.

Using the mental age norms of such instruments as the Stanford Binet and Leiter International Performance Scale as rough guidlines, the authors constructed a seriation test with an estimated mental age range of three and one half to seven years. The test had two subscales; trial and error in which subjects manipulated illustrated cutouts and pasted them in a record booklet, and operational, in which subjects designated their responses in the booklet with a pencil.

The children were tested by groups. Two weeks after the seriation test, subjects were given the Metropolitan Reading Readiness Test. Subjects were 356 kindergarten children selected from four schools: lower-class, Negro, segregated; lower-class integrated, (70% Negro); middle-class integrated (30% Negro); and segregated, white, middle-class.

The reliability of the seriation test as established for lower-class subjects was .91 and .94. There was a wide difference in seriation scores between race but a narrow difference within race. Differences between race were statistically significant, but variables of social class and interaction (race x social class) were not significant. The correlation between MRRT and seriation = .82. The seriation operational subtest was more closely related to MRRT variables than the seriation trial and error subtest. All three seriation scores correlated more with MRRT Reading Readiness than with MRRT number readiness but there was really little difference. The MRRT matching variable was more closely related to seriation than other MRRT variables.

Shantz, C. U. A development study of Piaget's theory of logical multiplication. Merril-Palmer Quarterly, 1967, 13, 121-137.

This study investigated the combination of two elements of multiplication of classes, two asymetrical logical relations, (longer and darker) and two asymetric spatial relations (above and to left of). Multiplication of classes was assessed by Raven's Progressive Matrices, Asymetric logical relations by a specially constructed multiple relations test of partially constructed matrices and the multiplication of spatial relations by a modified version of Piaget's landscape test in which subjects were asked to locate figures in relationship to their placement on a similar landscape. Seriation pretests were given to familiarize subjects with dimensions and ordering values. Subjects were 72 children of average IQ at 3 age levels, 7½, 9½ and 11½, equally divided between boys and girls, 24 subjects at each age level.

It was hypothesized that there would be a high correlation among the three multiplicative tasks within each age level. Results indicated a significant association among the tests for the 7½ & 9½ year olds. However, the oldest group, (11½ year olds) performed at levels which were not significantly related (P = .10). All three multiplicative abilities improved with age in an almost linear trend. Neither order of presentation of the tests nor sex were found to influence performance significantly.

Shapiro, B. J., & O'Brien, T. C. An investigation of children's logic. Boston University, mimeographed paper, 1970.

This study concerns three experiments conducted in an attempt to discover children's ability to test for logical necessity, i. e., their ability to handle "open items" presented in a syllogistic form. An open item was a syllogism in which the second premise was stated in the negative and the subject was given a choice of three modes of response; yes, no, or not enough clues. In the first experiment, a paper and pencil adaptation of Hill's Test for Logical Ability was administered to 245 upper middle class children in grades 4 to 12 (ages 9 to 17). The results indicated that the S's performed poorly on "open" if-then type questions particularly at the youngest age levels. Apparently, "if" was interpreted as meaning "if and only if", a procedure which the authors termed "child logic". Responses changed from "child logic" to a correct mathematical logic pattern with an increase in age.

The second experiment involved a different form of the previous test which was administered to 78 upper-middle class S's in grades 4, 6 and 8. The results closely paralleled those of the first experiment.

A third experiment was conducted with 125 low SES S's in grades 4, 6, 8, 10 and 12 in an attempt to determine the effect of a disadvantaged background. The same test as employed in experiment 2 was administered. The results showed that these S's were not only more dependent upon "child logic" than the middle class S's but that the proportion of these types of responses increased with age. The authors conclude that SES is an important factor in the development of some logical thinking abilities.

Sigel, I. E. The dominance of meaning. Journal of Genetic Psychology, 1954, 85, No. 2, 201-207.

Five classification tests were developed which required subjects to sort on the basis of similarity. The levels of symbolization and amount of manipulation allowed the subject were different. Test 1 was toy objects with manipulation allowed. Test 2 was toy objects with no manipulation. Test 3 was black and white photographs of toy objects with manipulation allowed. Test 4 was cards of names of toy objects. Test 5 was a typed list Of objects and subjects wrote down their groupings. Subjects were tested individually, asked to group objects and to give a reason for their groupings. Subjects were then asked to reclassify with fewer groups and give a reason for their groupings. This was repeated until the subjects could not reduce groupings. The last test was a recognition test given by the examiner in which the examiner grouped objects and the subject was required to state a reason for the grouping. Scoring was designated as either perceptual; based on structure, functional or locational similarities or conceptual; based on class membership. There were 60 subjects from ages 7, 9, and 11. Subjects were white, middle class boys who scored between 25 and 75 percent on Raven's matrices.

The subjects showed no significant differences in the methods of presentation or the amount of manipulation allowed. No differences occurred based on perceptual or conceptual grouping and regardless of stimulus presentation the Ss tended to respond in a similiar fashion. Specific concepts used by Ss in grouping were based primarily on the meaning of objects. The recognition test also gave further evidence of the dominance of meaning in grouping.

Sigel, I. E., & McBane, B. Cognitive competence & level of symbolization among 5 year old children. In J. Hellmuth (Ed.), *The disadvantaged child*. Seattle, Washington: Special Child Publications, 1967, 433-453.

An object sorting test containing three dimensional objects and photographs of the same was used to assess classification skills in children. Three types of categorizations were incorporated into the test materials: descriptive (an observable attribute such as color), relational (a functional relation such as a cup and a spoon), and inferential (a superordinate class encompassing all objects shown).

The subjects were 261 preschool children divided as to whites, Negroes, head start or non-head start. A measure of socioeconomic status was also taken into consideration.

The results of the study indicated that all S's tended to use descriptive categories most often when classifying. A socioeconomic status difference was found in which the lower SES subjects preferred color over form in classifications. In addition, these S's had trouble separating a part from the whole class of a subset. These results are discussed along with those of previous studies by Sigel and other researchers which tend to support the contention that SES differences do effect the child's ability to classify.

Wei, T. T. D. Piaget's concept of classification: a comparative study of advantaged & disadvantaged young children. Unpublished Doctoral Dissertation. University of Illinois, 1966.

Subjects were individually tested on four classification tasks chosen from Piagetian tasks: changing criteria, object classification, class-inclusion, and matrices. Subjects were 80 white children in

4 groups: 20 culturally-deprived and 20 middle-class kindergartners and 20 culturally-deprived and 20 middle-class second graders. An additional 20 Negro subjects were chosen to assess racial differences.

Results indicated that the ability to classify increases with age and that culturally deprived S's progress at a slower pace in classification than middle-class S's. There was a significant difference between grade levels as well as social class. Two years of schooling seemed to narrow the gap between culturally-deprived and middle-class, performance on the classification tests. Differences between races and sex were not found to be significant. The findings support Piaget's concept of sequence in logical development and relationship between development and chronological age.

Wohlwill, J. F. Responses to class-inclusion questions for verbally and pictorally presented items. Child Development, 1968, 39(2), 449-466.

Wohlwill reports on three studies of children's responses to classification questions when the latter are presented pictorially versus verbally. Experiment I involved 20 preschool children (mean age 5.11) and two sets of stimulus cards and questions. The design required an intial test and a posttest two weeks later. Half the S's received set A, the other half set B. Within each group, half were given the items verbally, then pictorially. For each administration, pictorially presented items elicited more correct responses, but the differences were insignificant.

Experiment II was conducted with 61 kindergarten S's (mean age 6.1) of lower-middle-class. In an effort to determine whether S's respond only to the number of objects in the sets, E administered Set A pictorally first as a pretest, twice more combined with instructions to count the objects in each item and finally as a posttest. The last presentation was followed by a verbal administration of the items. The results indicated a significant gain from pre to posttest, and a greater gain when the items were presented verbally.

Experiment III investigated the effect of varying the perceptual contrast between the subsets. Fifty-four kindergarten S's (mean age 5.5) of lower middle class were divided into three groups, each group being tested with verbal and pictorial sets of items. The results indicated that the S's performed best on the verbally presented items. However, the results indicated that while the S's performed best with the greatest degree of perceptual contrast, there was no overall verbal facilitation effect.

Wohlwill reports, but does not describe, a fourth experiment in which he assessed the relationship between the ability to understand class inclusion and other Piagetian tasks of conservation. He concluded that regardless of whether the measurements are based on verbal or pictorially presented items, class inclusion consistently precedes the acquisition of conservation.

Duncan, C. P. Recent research on human problem solving. Psychological Bulletin, 1959, 56, 397-429.

This is a review of studies of human problem solving published from 1946 through 1957. It focused on methods and amounts of training in the development of problem solving skills and variations in the presentation of a problem. There is also a summary of problem solving processes and theory. Examples of specific tasks are mentioned throughout the text.

Duncker, K. On problem-solving. Psychological Monographs, 1945, 58, (Whole No. 270.)

Duncker describes problem-solving and its processes in terms of 1930 Gestalt conceptions. Many problems are analyzed step-by-step in terms of the thought processes and strategies employed by Ss. Several useful problems are mentioned: the gimlet problem; box problem; pliers problem; weight problem; paperclip problem.

Frandsen, A. N., & Holder, J. R. Spatial visualization in solving complex verbal problems. Journal of Psychology, 1969, 73, 229-233.

The authors hypothesize that aptitude in spatial visualization facilitates mental solutions of symbol-manipulation-type problems, and that training in spatial visualization can improve the problem solving ability of those originally low in spatial visualization. Data supported both hypotheses. The instrument used to measure problem-solving ability contained the following types of items:

1. Syllogisms where the final conclusion was selected from four given answers.
2. Time-rate-distance problems in a story problem form with four choices given.
3. Logical deduction problems, which were also in a story problem form, but not of a mathematical nature.

Feldman, S., & Weiner, M. Problems in the construction and evaluation of tests for children from different socioeconomic levels. High School Journal, 1968, 51, 262-267.

From attempts to construct and validate a reading prognosis test for children of different SES levels, these authors concluded that most group tests are not adequate measures for low SES children because of the lack of score differentiation at the low end of the scale. Attempts to make up for the lack of differentiation on one test by rescoring items with partial credit or relying on teacher evaluations were not successful. Validation studies also showed significant differences between low SES black children in New York and low SES southern rural black children. Of 39 southern rural children, 66% scored in the perceptual discrimination area below the 5th percentile using NYC norms. In the beginning reading area 69% scored below the 6th percentile. In language 59% were below the 13th percentile.

Gagne, R. M. *The conditions of learning*. New York: Holt Rinehart, Winston, 1970.

In his chapter on problem solving Gagne describes his theory as one based on the importance of previously learned rules. Also important to his theory is the notion that problem solving is an internal process which speeds new learning. Gagne calls this new learning a higher order rule.

The conditions for problem solving also make up an important part of this chapter. Ease of recall, concept distinctiveness, fluency of hypotheses, and ability to match specific instances to a general class were listed as important ability factors in the learner. Contiguity of rules, recall of relevant facets, and verbal instructions were conditions listed as aspects of the learning situation.

He also discusses the relation between discovery and problem solving ability, the main link being that in problem solving the learner has to *discover* the higher order rule himself, but not without prerequisite knowledge or verbal guidance. In a discussion of problem solving ability and creativity, he points out that in creativity one must still have a repertory of previously learned rules, and mull them over in his mind before coming up with a creative new solution.

The final part of the chapter was concerned with strategies in problem solving focusing on mathemagenics and self-instruction rules.

Getzels, J. W. Creative thinking, problem solving, and instruction. *National Society for The Study of Education Yearbook*. 1964, *63*, 240-267.

Getzels surveys several views of PS: logical (Dewey), uniprocess (S-R) and dual process, factor analytic (Guilford), psychoanalytic (Freud-primary and secondary process), motivational (Hebb). He makes a distinction between presented problems and discovered problems and discusses several efforts to increase the creativeness of Ss: brainstorming, unusual uses tests, inquiry training.

Glaser, R., Damrin, D. E., & Gardner, F. M. The tab item: A technique for the measurement of proficiency in diagnostic problem-solving tasks. *Educational and Psychological Measurement*, 1954, *14*, 283-293.

The article is a description of the tab item, trouble shooting problem test. The test consists of 4 parts: A set of symptoms of malfunctioning (a tv set), a check-list of possible questions to ask or adjustments of tubes, etc. to make; results of those adjustments or answers to questions, and a list of possibly defective parts. Ss are instructed to find the trouble by asking the least number of questions.

Gorman, B. S., & Breskin, S. Non-verbal rigidity, creativity, and problem solving. *Perceptual and Motor Skills*, 1969, *29*, No. 3, 715-718.

Since rigidity vs. flexibility has been thought to be an important factor in creativity and problem solving, the authors used a non-verbal test of rigidity (the Breskin Rigidity Test) to explore the relation of rigidity to various paper-and-pencil measures of creativity and problem solving. They used the following tests:

1. semantic redefinition: the Re-2 object synthesis test (Guilford, 1967).
2. associational fluency: the Fa-3 associations IV test (Guilford, 1967).
3. inductive reasoning: the I-1 letter sets test (French, et.al., 1963).
4. figural completion (Barron, 1958; Frank & Rosen, 1949) given simple lines & curves expand them into new figures-rated as creative or non-creative.

Rigid subjects were found to perform significantly more poorly than flexible subjects on all tasks, except on the associational fluency test. In explaining these results the author states that the semantic redefinition test is considered by Guilford to be the opposite of "functional fixity", and should therefore be difficult for rigid subjects. In the Letter Sets Test, items are arranged so that a new PS set is required for the solution of each test item. Flexible subjects would be able to discard sets more easily than rigid subjects. The associational fluency test requires high-scoring subjects to have a large vocabulary, and since there was no verbal factor in the rigidity test, this may account for there being no significant difference.

Gruen, G. E., & Ottinger, D. R. Skill and chance orientations as determiners of problem-solving behavior in lower and middle class children. *Psychological Reports*, 1969, *24*, 207-214.

The problem-solving task consisted of a 3-choice discrimination learning task, where one choice was rewarded 66% of the trials and the other 2 choices were never rewarded (Third grade subjects). The task was hopefully novel and equally unfamiliar to both lower & middle class children. All children see it as a problem-solving situation and generate hypotheses and try strategies to solve it. Middle-class children continued making more LMR (left, middle, right) and RML responses. Lower-class children maximized their responses more (chose the one that was paying off). Results seem to indicate that middle-class children have high expectancies of success and are not satisfied with 66% success. They see tasks as dependent upon their own actions (are more *skill*-oriented). Lower class children are satisfied with this level of success and are more *chance*-oriented). They perceive outcomes of a task more as independent of their own actions and unpredictable.

Guilford, J. P. *The nature of human intelligence*. New York: McGraw-Hill, 1967.

A model of PS and creative production is presented based on the structure-of-intellect model and information-processing models. A wide variety of types of problems are discussed which have been used in Guilford's measurement of convergent and divergent production abilities. Of possible usefulness for the present investigation might be: anagrams (DSU); match problems (DFT), triangle puzzle (DFT); remote associations (DMT); equations (DSI); and making objects (DFS). All of these tasks require Ss to go from known information, manipulate that information in some way and obtain a final product not originally perceptible.

Hunt, E. Computer simulation: Artificial intelligence studies and their relevance to psychology. *Annual Review of Psychology*, 1968, *19*, 135-168.

In his review of artificial intelligence, the author described various computerized models for simulating human problem-solving behavior. He indicated that while most computerized models use linear step-wise organization, many human problem-solvers tend to use widely varying procedures which are not analogous to a set of linear steps. However, some human problem-solvers, perhaps those who have had some specific training in techniques of problem-solving, follow mechanically a set of steps in much the same fashion as the computer model. The author also covers decision making, which he regards as closely related to problem-solving behavior. The simulation of the cognitive or PS processes involved in such games as chess and checkers and in "real-life" games also serves to clarify basic processes in PS behavior. Hunt concludes that research in computer simulation and artificial intelligence are not yet carried out with sufficient attention to the man-machine parallels, but nevertheless important insight about human PS behavior can be derived from this area of research.

John E. R. Contributions to the study of the problem solving process. *Psychological Monographs*. 1957, *71*, (18, Whole No. 447).

John believed that most problem solving work is too bogged down with specialized subject matter. He contended instead that the ideal format for problem-solving should: (1) start the subject with a standard minimum of information about the problem and require the subject to structure his own presolution behavior with minimal constraint; (2) problems should be free of special skills, knowledge, or experiences which are culturally specific; (c) familiarity with the generic task should be minimal; (d) one should be able to vary and quantify difficulty; and (e) the format should allow subjects to interact with real rather than abstract events.

Consistent with the notion that problems consist of two aspects: elements and relationships, this paper describes a problem solving and information apparatus where the logic of relationships between elements can be stated in terms of symbolic logic devoid of factual content. This device was used to study individual work habits, information variables, and approach variables.

Johnson, D. M. Solution of anagrams. Psychological Bulletin, 1966, 66, 371-384.

This study reviews research concerned with the importance of set in problem solving and discusses several variables of anagram solution. The author concluded that well patterned letter groups are more difficult to reorganize than loosely grouped ones. Word anagrams are more difficult than nonsense anagrams. It was also pointed out from the work of Mayzner and Tresselt that there is a strong relation between the frequency of the word and solution time. Words of high digram frequency are constructed more quickly than words of low digram frequency, and anagrams most similar to the solution word are easier to solve at all levels of frequency.

Research on anagram solving abilities and processes was also reviewed.

Johnson, D. M., Parrott, G. R., & Stratton, R. P. Productive thinking: Produce one solution or many. Proceedings of the 75th annual convention of The American Psychological Association, 1967, 2, 299-300.

This study was a comparison of the quality of production of responses in situations where only one response was called for as opposed to producing many possible solutions for the same questions. Plot titles, table titles (making inferences from a graph), conclusions, sentences (using four given words to make a sentence) and cartoon completion made up the test battery.

It was concluded that students who write many solutions, as opposed to one solution responses, write more superior more, mediocre, and more inferior solutions. Because they write more solutions at all levels of quality, even if the mean is lower, they still write more of superior quality.

Karlins, M., Coffman, T., Lamm, H., & Schroder, H. The effect of conceptual complexity on information search in a complex problem solving task. Psychonomic Science, 1967, 7, 137-138.

War type games were employed in this research. Ss had to find out information about a convoy they were in charge of. They were required to write out questions to get information. Number and type of questions were recorded.

Integratively complex Ss asked more questions; requested more answers dealing with detection of objects by use of radar; and requested fewer answers dealing with the enemy directly.

Ss were given charge of a convoy through enemy territory. Principal tasks were to maintain effective vigilance in and around task force and assure readiness to defend her forces from enemy attack by effective gathering and analysis of information based on radar reports. Ss began with no knowledge of the components of his own or the enemy's forces.

Keislar, E. R. Teaching children to solve problems: A research goal. *Journal of Research and Development in Education*, 1969, *3*, 3-14.

This paper offers a basis and direction for the development of problem solving tests. In lieu of a taxonomy of problem solving ability the author lists work in which problem events may be described. These events were grouped into four classes: (1) environmental events; (2) problem solving process; (3) nature of learning outcome; and (4) individual differences.

The question of open ended versus goal directed methods of teaching problem solving was discussed and the following suggestions for the development of problem solving tests were made:

1. The population of problems being sampled by the test should be appropriately defined.
2. The population of problems should be important. (It was suggested that justification for anagrams or puzzles may be difficult to make and also that it is difficult to be sure that a test generalizes to other tasks or skills.
3. The test should not be inadvertently confounded with previous learnings. (This can be accomplished by making test material familiar enough so that all students will have background, by screening students, or by presenting criterion level material in the test question.)
4. Conditions for giving the test must be clearly specified.
5. Test should indicate how well children were following appropriate procedure. One can also provide an increasing number of cues.
6. When only "right" or "wrong" answers are accepted, it is difficult to assess where the trouble lies. Have students record all steps toward the solution.
7. Problem setting can be assessed apart from problem solving.
8. Amenable to group presentation. Audio visual aids may be helpful.

Keislar, E. R., & Stern, C. Differentiated instruction in problem solving for children of different mental ability levels. *Experimental Publication System*, 1970, (7), Ms. 239-234.

This study indicates that mental age is a significant variable in problem solving ability. Children with higher mental ages do relatively better using a more complex but more efficient scanning strategy; those with lower mental ages profit relatively more with the use of a simpler gambler's strategy.

Rimoldi, H. J. A., Devane, J. R., & Haley, J. Characterization of processes. *Educational and Psychological Measurement*, 1961, *21*, 383-392.

The authors discussed a hypothetical experiment in which Ss *selected* questions in order to solve a problem (medical diagnosis). They described the means used to establish relative usefulness of various questions. (Rimoldi, 1955, 1960).

Scandura, J. M. Prior learning, presentation order, and prerequisite practice in problem solving. *Journal of Experimental Education*, 1966, *34*, 12-18.

This author used concept formation card tasks to study the effect of presentation order, prior learning, and prerequisite learning in problem solving. His conclusions were that problem solving performance improved:

a. by pre-experimental availability of prerequisite material. (This finding held even after repeated re-introduction of criterion level materials, hints and practice in problem solving.)
b. when prerequisite material was presented prior to criterion material.
c. by prerequisite practice only when prerequisite material came first.

Schulz, R. W. Problem-solving behavior and transfer. *Harvard Educational Review*, 1960, *30*, 61-77.

Schulz views PS as a matter of transfer of training. He applies several PS situations: functional fixation, detour problem, Luchins water jar, and anagrams to the transfer of training paradigm and concludes that problems arise when there is a considerable amount of *negative* transfer of previously acquired habits (or responses).

Silverman, P., Koos, E. M., Fellhauer, E. *Explorations in biology: Introductory problem. The egg-eating snake*. Kansas City: Mid-continent Regional Educational Laboratory, 1970.

These authors reported on the development of a multiple-choice instrument to measure Ss ability to plan a "step-by-step" investigation of a problem in biology. Ss are shown a series of pictures and asked to interpret diagrams and passages in an effort to solve the problem. The program also includes corrective and review features.

Staats, A. W., & Staats, C. K. *Complex human behavior*. New York: Holt, Rinehart, & Winston, Inc., 1963.

These authors interpreted problem solving in terms of response hierarchies. Past experience plays a significant role by making certain responses more dominant in the hierarchy. Language is extremely important as a mediator. Verbal response chains can facilitate or inhibit PS behavior depending on the relevancy of associations to correct solution.

Stafford, K. R. Problem solving as a function of language. *Research in Education*, 1967, *2*(4), 2.

The author studied the problem-solving abilities of 8th grade monolingual and bilingual Navaho students, using an apparatus composed of a screen divided into quadrants, a button beside each quadrant to be pushed by the subject and a reward light above the screen. Each problem involved the discovery of a pattern of responses to the geometrical figures which appeared within various quadrants and only the correct solution would lead to consistent reward light flashes.

It was hypothesized that subjects speaking Navaho only would score lower than bilingual subjects on these problems involving the manipulation of encoding, since Navaho is a thing-based rather than an idea-based language. This hypothesis was supported.

Stalcup, R. J. *Explorations in biology*: Topic 3. *Bird agression, Book B*. Kansas City: Mid-Continent Regional Educational Laboratory, 1970.

Instrument for measuring "inquiry" skills are given. He uses an MC format where the problem is stated and Ss are asked to indicate how they would proceed to investigate the problem. Graph reading and interpretation and knowledge of experimental control and design variables are tested.

Stern, C. Problem solving and concept formation: A comprehensive bibliography. *Research in Education*, 1969, *4*, (7), 26.

This is a comprehensive bibliography on problem solving and concept formation, 1924-1967 with special emphasis on problem solving in young children.

Stevenson, H. W., Hale, G. A., Klein, R. E., & Miller, L. K. Interrelations and correlations in children's learning and problem solving. *Society for Research in Child Development Monographs*, 1968, *33*, (7), (Whole No. 123.)

These researchers administered a battery of 12 tasks to 3rd through 7th graders and correlated the results with measures of IQ, achievement, and teacher ratings. Four PS tasks were used: two probability tasks, conservation of volume, and anagrams (form many words from one). All correlations were fairly high (.40+).

Suchman, J. R. The elementary school training program in scientific inquiry. Champagne: University of Illinois, 1962.

The function of the Problem-Episode Film in inquiry training is to present a clear picture of a physical event and to pose a question about its causation. It marks out an area for investigation and generally motivates the learner to find an explanation. Finally, it presents a limited set of data. The inquiry films are designed to disequilibrate the learner by presenting discrepant events that he cannot fully explain and/or could not have predicted.
Four types of processing have major roles in inquiry:

1. Analysis - the breaking down of data complexes into their component parts.
2. Comparison - the bringing together of comparable elements to make similarities and differences more evident.
3. Isolation - the selective separation and attention to small groups of variables to reduce the cognitive strain that results from excessive diffusion of attention.
4. Repetition - the repeated juxtaposition of data elements to decrease the probability of unrecognized relationships.

Tate, M. W., Stamier, B., & Harootanian, B. Differences between good and poor problem-solvers. Philadelphia: School of Education, University of Pennsylvania, 1959.

The authors studied suburban seventh and eighth graders to find variables which discriminated between good and poor problem-solvers and how these variables account for problem-solving ability. The following tests of reasoning and problem-solving ability were used:

Differential Aptitude Tests of verbal,. abstract, and mechanical reasoning
Davis - Eels Games
Standard Progressive Matrices
Thought Problems (constructed by the authors)

A variety of other related types of tests were administered in a later battery, including tests of problem recognition, word association, ideational fluency, memory, closure, and judgment or evaluation.

In later individual testing, six measures of rigidity were used, each of which consisted of six items which established a set that must be broken to solve the last item. The score is the ratio of the median time taken to solve the set items to the time on the last item.

A review of PS literature is also included in the study. Important variables were found to be: problem recognition, judgement, intelligence, and reading ability.

Tyler, R. B. Expectancy for eventual success as a factor in problem solving behavior. *Journal of Educational Psychology*, 1958, *49*, 166-172.

Tyler found that the more the problem was perceived as possible of successful completion, the better the individual's performance was in the problem-solving situation. Task employed was that of guessing what sequence of flashing lights was correct. Expectancies were developed by means of verbal comments, designed to encourage or discourage.

Underwood, B. J. *Experimental psychology, second ed*. New York: Appleton-Century-Crofts, 1966.

In his chapter on problem solving the author gives an extensive analysis of the work done in the area of anagrams. Concept recognition is also discussed, where subjects were required to give the appropriate descriptive term to fit a group of words, or tell how a group of words were related. Response dominance or strength of association plays a large part in determining difficulty of these tasks. Experiments in the breaking of an established PS set are described, using water jar problems and anagrams. The role of probability, stimulus dominance, functional fixedness, and memory in problem solving is also discussed.

Upton, A., & Samson, R. W. Creative analysis: The graded exercises in analysis. New York, Dutton, 1963.

The author stresses a language approach to problem solving, using words as PS tools. As series of exercises are proposed with this aim on the high school and college level. In a simplified theory of problem-solving, seven stages essential to the solution of complex problems are proposed.

Weir, M. Age and memory as factors in problem solving. *Journal of Experimental Psychology*. 1967, *73*, (1), 78-84.

This study used the marble dispenser problem and found that 9 year olds *with memory aids* of past responses choose the payoff pattern more frequently and make fewer simple response patterns than adults or 5 year olds. Without the memory board 9 year olds tend to stick with patterned strategies whether they pay off or not.

Werdelin, I. A synthesis of two factor analyses of problem solving in math. *Didakometry*, (Molms, Sweden School of Education), 1966, *8*.

This was a factor analysis study. Five factors relevant to the process of problem solving were isolated: (a) general reasoning, (b) deductive reasoning, (c) verbal comprehension, (d) a space factor, and (e) a numerical factor. Problem solving depends most on the factor of general reasoning.

Wertheimer, M. Productive thinking, second ed. New York: Harper & Brothers Publishers, 1959.

The author investigates the thinking process, how it actually proceeds, and looks at its many component parts or steps. He discusses crucial problems with concrete examples of productive thought and gives the Gestalt interpretation of thinking.

Westcott, M. R. Empirical studies of intuition. In C. W. Taylor (Ed.), Widening horizons in creativity. New York: John Wiley & Sons, 1964.

The author reports on a study done by Bouthilet in 1948 where subjects were given 20 paired associates in a training session in which the associate word was made up of letters in the stimulus word. In the test that followed, subjects were to choose one of five words to go with each stimulus word. Subjects were able to choose the correct associates on better than a chance basis even before they were able to state the principle involved.

A study done by the author to obtain information on the different types of problem solvers and their characteristics used a sequence of clues selected by the subject to solve a problem with the least number of clues possible. The tasks used were series and analogies problems, each in both a numerical and a verbal form. Results show that an individual may be high and low on information demand and still be either high or low in success. Another type of task is a series of fragmented pictures, where each picture is more complete than the last and the subject must identify the picture as early as possible. Older subjects do better and are less variable in solutions of this task.

In using a 20 questions type task, Mosher (1962) found developmental changes in children's PS strategies. Older children ask more questions which progressively narrow the field of possible solutions.

A- Locus of Control
Annotated Bibliography

Battle, E. S., & Rotter, J. B. Children's feelings of personal control as related to social class and ethnic group. Journal of Personality, 1963, 31, 482-490.

The Bialer I-E scale was administered to 80 Negro and White sixth and eigth graders. Results showed that middle-class Whites were internally controlled while lower-class Negroes were externally controlled. James's line matching task in which the experimenter controls the outcome and subjects predict their success was also given. Internal control subjects were more certain of success than external control subjects. Finally, a projective test consisting of six cartoons was tested and found to correlate well with the Bialer scale.

Bialer, I. Conceptualization of success and failure in mentally retarded and normal children. Journal of Personality, 1961, 29, 303-320.

Forty-four normal children and 45 educable retardates, grades 1-8, were given a series of three tests. The Locus of Control Scale consisted of 23 yes-or-no items and was scored for external responses. The Repetition Choice situation involved being interrupted during the completion of one of two tasks. Scoring was choice of interrupted or noninterrupted task. Finally, a series of three Delay of Gratification situations was presented. Results indicated that as mental age and chronological age increase, there is a significant trend for locus of control to become internal, repetition choice to be for the interrupted puzzle, and choice for the delayed gratification. Mental age was more predictive than chronological age and retardates did not differ qualitatively from normals.

Butterfield, E. C. Locus of control, test anxiety, reactions to frustration, and achievement attitudes. Journal of Personality, 1964, 32, 355-370.

Forty-seven introductory psychology students were given the following series of tests: Locus of Control scale, Frustration-Reaction Inventory, Test Anxiety Inventory, and Achievement Attitudes Inventory. Intercorrelations among these tests indicated that frustration reactions were less constructive as locus of control became more external, that debilitating anxiety reactions decreased and facilitating anxiety reactions increased as LC became more external, and that internal LC had a greater range of expected grades but received higher grades than external LC.

Crandall, V. C., Katkovsky, W., & Crandall, V. J. Children's beliefs in their own control of reinforcements in intellectual-academic achievement situations. *Child Development*, 1965, *36*, 91-109.

This article describes the characteristics of the Intellectual Achievement Responsibility (IAR) Questionnaire. A copy of the complete IAR is included the IAR has two subscales, a responsibility for success scale and a responsibility for failure scale. The IAR was administered to 923 elementary - high school students and found to have a short range, small amount of variance, and a mean nearer the internal end. A two-month test-retest correlation was .69. The IAR scores were only moderately related to I.Q. and socio-economic status and thus may be measuring a motivational variable.

Crandall, V. J., Katkovsky, W., & Preston, A. Motivational and ability determinants of young children's intellectual achievement behaviors. *Child Development*, 1962, *33*, 643-661.

Forty first, second, and third graders were given an extensive battery of achievement tests. These tests were related to four achievement measures: I. Q., California Achievement Tests, amount of time and intensity of striving in intellectual activities during free play. Need achievement and manifest anxiety measures did not predict achievement. Intellectual attainment value did predict achievement for girls while stated expectations were positively associated for boys.

Davis, W. L., & Phares, E. J. Parental antecedents of internal-external control of reinforcement. *Psychological Reports*, 1969, *24*, 427-436.

Introductory psychology classes were given the 23 item I-E scale by Rotter. One group of high and low scorers was given the Children's Reports of Parental Behavior Inventory. No significant relationships were found between the tests. The parents of a second group of high, middle, and low scorers completed the I-E scales and the Maryland Parent Attitude Survey. Again no significant main effects were found, but results indicated that fathers of internals were more indulgent and less protective than fathers of externals.

Feather, N. T. Valence of outcome and expectation of success in relation to task difficulty and perceived locus of control. Journal of Personality and Social Psychology, 1967, 7, 372-386.

A task in predicting the success of a hypothetical subject and rating the attractiveness of his success in a game of increasing difficulty was given to a group of introductory psychology students. One half of the group was told that success was based on skill while the other half believed it was due to chance. Results showed the importance of the situational context; attractiveness of success was greater and the repulsiveness of failure was less as task difficulty increased. Rate of change was greater for the skill group. Three personality tests, including the I-E scale, were administered and found to be unrelated to to performance on the task.

Gozali, J., & Bialer, I. Children's locus of control scale: Independence from response set bias among retardates. American Journal of Mental Deficiency, 1968, 72, 622-625.

Bialer's I-E scale has a preponderance of "yes" responses for internal locus of control. Mentally retarded subjects were tested for response set on the I-E scale. The item reversal technique in which the same items are presented in original and reverse form to all subjects was used. High correlations were obtained between original and reverse forms of the Bialer test demonstrating a lack of response set in mentally retarded subjects on the test.

Gurin, P., Gurin, G., Lao, R. C., & Beattie, M. Internal-external control in the motivational dynamics of Negro youth. Journal of Social Issues, 1969, 25.

The University of Michigan Survey Research Center examined locus of control in three Negro college and college-aged populations. The authors suggest that the internal-external dimension of Rotter's I-E scale is actually a number of dimensions and they propose two such distinctions. First, the self-other dimension refers to explicit statements on an individual's responsibility as opposed to general statements on persons rather than fate, controlling events. No differences were found between Whites and Negroes on the ideological dimension but there were clear-cut race differences on the personal dimension with Negroes being more external. Performance measures were positively related to internal scores on the self-other dimension. The second distinction is the individual-system blame dimension which refers to responsibility for failures. Performance measures had no relation to this dimension but Negroes scoring external here were more likely to aspire to nontraditional jobs and to support collective action in the civil rights area.

Harrison, F. I. Relationship between home background, school success and adolescent attitudes. Merrill-Palmer Quarterly, 1968, 14, 331-344.

The author developed an attitude questionnaire to measure four aspects of attitude toward school among high school students. The inconsistent student, defined as a successful disadvantaged student and an unsuccessful advantaged student, was found to have attitudes toward school which were not congruent with their respective majority groups. Success or nonsuccess was a more important determinant of like attitudes than was advantaged-disadvantaged. On the attitude toward education scale, all subjects were similar.

Lefcourt, H. M. Risk-taking in Negro and White adults. Journal of Personality and Social Psychology, 1965, 2, 765-770.

While a number of investigations have shown that Negroes have a more external locus of control when compared to Whites, this study found that Negroes display more internal control behavior than Whites in a chance situation. Sixty former narcotic addicts, all male, played a dice game. They were provided with a payoff matrix. Results showed That Whites selected more low probability bets and made more shifts in betting.

Katkovsky, W., Crandall, V. C., & Good, S. Parental antecedents of children's beliefs in internal-external control of reinforcements in intellectual achievement situations. Child Development, 1967, 38, 766-776.

In study A, 41 children were given the Intellectual Achievement Responsibility questionnaire and their mothers were given the Parent Behavior Rating Scales. Significant positive relationships were found between a child's, especially male, internal locus of control and a mother's protectiveness, approval and affection. Study B related IAR scores for 40 children with personal interviews and Parent Reaction questionnaire scores for both parents. For both sexes, positive reactions by fathers were associated with the child's especially female, internalness and negative reactions with externalness.

Lefcourt, H. M., & Ladwig, G. W. Alienation in Negro and White reformatory inmates. Journal of Social Psychology, 1966, 68, 153-157.

A group of 60 Negro and 60 White males was given Rotter's Level of Aspiration scale, Rotter's I-E scale, and Dean's Powerlessness and Normlessness scales. Negroes scored more external locus of control than Whites on all of these tests.

Lessing, E. E. Racial differences in indices of ego functioning relevant to academic achievement. *Journal of Genetic Psychology*, 1969, *115*, 153-167.

The subjects in this study consisted of eighth and eleventh grade Negro and White students. Two attitude scales, a Personal Control scale and a Delay of Gratification scale, seven items each, were administered. Negro children were found to have significantly less sense of personal control and were less willing to delay gratification. Negro students had significantly lower grade point averages and I. Q. scores.

McGhee, P. E., & Crandall, V. C. Beliefs in internal-external control of reinforcements and academic performance. *Child Development*, 1968, *39*, 91-102.

This article reports two studies in which the Intellectual Achievement Responsibility questionnaire was administered. In the first study, the grades and achievement test scores of 923 elementary through high school students were used in conjunction with the IAR. Those having high grades scored significantly more internal control than those having low grades, but no significant relationships were found with achievement test scores. In study two, the same relationship between grades and internal control was found for males but did not reach significance for females.

Rotter, J. B., & Mulry, R. C. Internal versus external control of reinforcement and decision time. *Journal of Personality and Social Psychology*, 1965, *2*, 598-604.

One hundred twenty introductory psychology students were given the I-E Control scale and a series of angle matching tests. One-half of the subjects were told that the tests were based on skill, the other half believed that correct matching was due to chance. In both training, when some of the responses were called correct, and in extinction, when all responses were incorrect, internals in the skill group took significantly longer than externals to decide on a correct match while in the chance condition externals took significantly longer to decide than did internals.

Shaw, R. L. Relationship between locus of control scores and reading achievement of black and white second-grade children from two socioeconomic levels. Paper presented at Southeastern Psychological Association, New Orleans, 1969.

Reading ability was assessed by the Stanford Achievement Test for 211 second graders, both black and white. The Bialer-Bromwell Locus of Control scale was also given. White upper-middle class children were significantly less external than other groups. This was also the only group in which reading achievement was related to locus of control. White middle class students were internally controlled and scored higher on reading ability. The Bialer-Cromwell scale had a reliability coefficient of only .33.

Solomon, D., Houlihan, K. A., & Parelius, R. J. Intellectual achievement responsibility in Negro and White children. *Psychological Reports*, 1969, *24*, 479-483.

The Intellectual Achievement Responsibility questionnaire was given to two groups, all white fourth and sixth graders and all Negro fourth and sixth graders, which were matched by parental occupation. This test assesses the amount of responsibility assumed in intellectual and academic situations. The only significant relationship found was that girls scored higher than boys in internal responsibility scores.

Tin-Yee Hsieh, T., Shybut, J., & Lotsof, E. J. Internal versus external control and ethnic group membership. *Journal of Counsulting and Clinical* Psychology, 1969, *33*, 122-124.

Rotter's I-E scale was given to 239 Anglo-American, 80 American-Chinese, and 343 Chinese (Hong Kong) high school students matched for socio-economic status. Significant differences were found between all three groups. Chinese students were the most external, Anglo-Americans the most internal, and American-Chinese in the middle.

Walls, R. T., & Smith, T. S. Training of preference for delayed reinforcement in disadvantaged children. *Journal of Educational Psychology*, 1969, in press.

Two training conditions were used with 45 disadvantaged and 45 middle class second and third grade children to train delay of immediate reinforcement for a larger reward later. An instrumental work task did not improve willingness to delay when compared to a control group but the learning set condition did significantly improve delay choices. Nondisadvantaged subjects made significantly more delay selections than disadvantaged subjects. Locus of control was found to be related to time perception: internally controlled subjects more often chose delay and had a more accurate perspective of time.

Response Styles

B - Impulsivity-Reflectivity

Annotated Bibliography

Briggs, C. H. An experimental study of reflection-impulsivity in children. Dissertation Abstracts, 1968, 28(9), 3891-B.

One hundred forty-five middle class boys, fourth grade, were classified as reflective, middle, or impulsive on the basis of the Matching Familiar Figures (MFF) task. The training task reinforced response latency although subjects were told that reinforcement was determined by their matching performance. One half of each group was reinforced for increasing their latency, one half for decreasing it. Modified yoked controls were used. A post-MFF test showed significant differences in the direction reinforced during training.

Coyle, P. J. Differences in reflection-impulsivity as a function of race, sex and socioeconomic class. Dissertation Abstracts, 1967, 27(12), 4549-B.

Sixty fifth grade children were classified by parental occupation as culturally deprived, core culture, or middle class. Results indicated that Negro children were more reflective; they had significantly longer latencies, fewer errors, and more correct responses on the first trial than did white children. Culturally deprived children made significantly more errors and had fewer correct responses on the first trial than middle class children.

Drake, D. Perceptual correlates of impulsive and reflective behavior. Developmental Psychology, 1970, 2(2), 202-14.

While the MFF was administered to 18 upper middle class third graders and 16 undergraduates, eye fixations were recorded. The MFF was also given in a T.V. presentation. Reflective children and impulsive adults spent significantly more time looking at a standard stimulus during the first six seconds and looked at a larger area of it. Reflective subjects made twice as many comparisons. Only reflective adults looked at all stimuli before answering.

Gentile, L. A. An investigation of the relationship between the reflectivity impulsivity cognitive dimension and psycholinguistic abilities. Dissertation Abstracts, 1968, 29(5), 1449-A.

The Illinois Test of Psycholinguistic Abilities (ITPA) and the MFF were given to 50 white, third grade boys. The subjects were classified as reflective or impulsive on the basis of the MFF. Significant differences were found on the Auditory-Vocal Association and Auditory-Vocal Automatic subtests of the ITPA with impulsive boys scoring lower than reflective boys. Impulsive boys scored less well than reflective boys on ability to predict future linguistic events. I.Q. accounted for the largest amount of variance.

Kagan, J. Developmental studies in reflection and analysis. In A. H. Kidd, & J. L. Rivoric (Eds.) Perceptual development in children. New York: International Universities Press, 1966.

This chapter reviews a dozen investigations of reflectivity and visual analysis in middle-class children from the first four grades. The evidence is interpreted as supporting Kagan's notion that reflection over alternative solution possibilities and visual analysis are fundamental cognitive dispositions that are independent of each other and of verbal ability. Visual analysis and reflection are viewed as complementary processes. In order to select the correct variant on the Conceptual Styles Test (CST) or Matching Familiar Figures (MFF) Test, for example, one must analyze each component into its components, inhibit the immediate reporting of initial hypotheses, and evaluate alternative solution possibilities. Brief descriptions are given in this chapter of the following tasks of reflectivity: CST, Delayed Recall of Designs (DRT), MFF, and Haptic-Visual Matching (HVM). The Visual Analysis Task is also described.

Kagan, J. Information processing in the child. In P. H. Mussen, J. J. Conger, & J. Kagan (Eds.) Readings in child development and personality. New York: Harper & Row, 1969.

A section of this textbook reviews impulsivity-reflectivity. When the Delayed Recall of Designs test (DRT), the Haptic Visual Matching test (HVM), and the MFF are administered to grades 1-4, there is a linear increase in response time and decrease in errors. Reflectiveness increases with age. The factors of caring and involvement producing reflectivity and getting done quickly producing impulsivity are discussed. The hypothesis that minimal brain damage near birth produces restlessness and impulsivity is presented.

Kagan, J., Moss, H. A., & Sigel, I. E. Psychological significance of styles oc conceptualization. Monograph of the Society for Research in Child Development, 1963, 28(86)(Whole No. 2), 73-112.

This article reports a series of eight studies on the analytic dimension of problem solving with various populations. The studies employed the Conceptual Style Test (CST) in conjunction with differing tasks. Included in the findings are: Among sixth graders who were given a serial learning task, analytic subjects recalled conceptually related words while nonanalytic subjects recalled functionally related words. Forty-six third graders were tested one year after their original testing. Analytic responses showed high stability for girls and moderate stability for boys. Highly analytic fourth graders attached new verbal responses to less salient parts of a geometric design. Finally, analytic responses were significantly related to longer response times in sixth graders.

Kagan, J., Pearson, L., & Welch, L. Modifiability of an impulsive tempo. Journal of Educational Psychology, 1966, 57(6), 359-363.

First graders were classified as impulsive or reflective on the basis of the MFF and two Weschler verbal scales. In a training session, it was suggested to impulsive subjects that they were like an experimenter who always thought before answering. All subjects in the training group had slower response times in the posttest. A perceived similarity between subject and experimenter nearly reached significance in affecting pre-post changes.

Kagan, J., Rosman, B., Day, D., Albert, J., & Phillips, W. Information processing in the child: Significance of analytic and reflective attitudes. Psychological Monographs, 1964, 78(1), (Whole No. 578).

A series of eight studies on analytic and reflective attitudes is described which used the CST as the basis for classification. The subjects were middle class elementary students. When several responses were simultaneously available, a dimension of reflectivity versus impulsivity was identified and found to be stable across the DRT, MFF, and HVM. Third and fourth graders showed high stability on this dimension over a one year test period. Fourth grade boys showed a strong correlation between analytic concepts and a tendency to analyze geometric stimuli into distinct components. Reflection was found to be independent of visual analysis. A relationship between impulsivity and restlessness was found in third graders as was a relationship between highly analytic answers and less spontaneous gross motor behavior.

Kagan, J., & Rosman, B. L. Autonomic correlates of attention and an analytic attitude. Journal of Experimental Child Psychology, 1964, 1, 50-63.

Fifty-five first and second grade boys were classified on the basis of the CST. During a forty minute session with a variety of tasks, respiration and heart rate were measured. Analytic subjects displayed lower variability in respiratory variability and a lower average heart rate.

Lee, L. C., Kagan, J., & Rabson, A. The influence of a preference for analytic catergorization upon concept acquisition. Child Development, 1963, 34(2), 433-442.

Thirty male third graders who scored highest and lowest on the CST were given a learning task in which 54 pictures representing six conceptual classes (9 each) were paired with nonsense syllables. The anticipation method was used and pairing continued until the subjects gave all correct responses. Results showed that the analytic boys learned the two analytic concepts at fast rates and the two relational patterns at slower rates while the nonanalytic boys learned the analytic concepts at slower rates and the relational patterns at faster rates.

Nelson, T. F. The effects of training in attention deployment on observing behavior in reflective and impulsive children. Dissertation Abstracts, 1969, 29(7), 2659-B.

Sixty-five suburban, middle class boys in fourth grade were classified as reflective or impulsive. A match-to-sample reflective strategy was suggested by the experimenter and was effective in influencing the subjects to give more observing responses. A yoked control design was used.

Ward, W. C. Creativity and impulsivity in kindergarten children. Dissertation Abstracts, 1966, 27(6), 2127-B.

Latencies among five measures of impulsivity were significantly intercorrelated for 87 subjects with diverse I.Q.'s and socio-economic status. Three creativity measures were also given. Subjects high on both creativity and intelligence formed the most reflective subgroup.

Zucker, J., & Stricker, G. Impulsivity-reflectivity in preschool head start middle class children. Journal of Learning Disabilities, 1968, 1(10), 578-583.

This study compared lower-class Negro and middle-class white children of preschool age on a task designed to measure perceptual tempo (Matching Familiar Figures Test). They hypothesized and found that the lower-class Negroes had shorter latencies of response. Also, boys were slower in responding than girls.

A Bibliography of the Literature of
the Measurement of Cognitive Development
in Elementary School Children

This bibliography, like the literature review and the annotated bibliography which preceed it, is organized into five sections:

concept formation
language development
logical thinking
problem solving
response style.

Both the published and unpublished literature is included in the listings. Occassionally a citation appears in more than one section of the bibliography. It was felt a small amount of redundancy was permissible in order that each bibliographic section could stand as a comprehensive list of the literature available in that area.

Concept Formation

Almy, M., Chittenden, E., & Miller P. *Young children's thinking - studies of some aspects of Piaget's theory*. New York: Teachers College Press, 1966.

Annett, M. The classification of instances of four common class concepts by children & adults. *British Journal of Educational Psychology*, 1959, *29*, 223-236.

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Becker, J. T. The effect of group administration of selected individual tests of language, visual perception and auditory perception by kindergarten, first-, second-, and third-grade children. Unpublished Doctoral Dissertation: Catholic University, 1969.

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Related Measures and Research Design

This section of the report contains a review of the typical literature associated with achievement measures and cultural deprivation. The case for a careful study of mediational variables such as those identified with cognitive functioning is reiterated in this literature. A bibliography on achievement testing as well as annotations for the most relevant citations are included.

Recommendations for the specific achievement tests to use in connection with the new tests of cognitive development are made. Finally our plans for data collection and for the analysis of data together with the justification for these plans are reported in the last portions of the section.

Review of the Literature on Achievement Testing

Decrements in achievement among the disadvantaged are among the most fully documented observations of this decade. Whether fact or artifact, the tests available reveal that minority groups and groups of low socioeconomic status start first grade with substantially lower conceptual skills than the White majority and fall progressively behind as they move through school to the twelfth grade (Brunson, 1969; Coleman, 1966; Hanson, 1967; Rosenfield, 1969).

Studies of race, socioeconomic status and intelligence have failed to identify one strand which consistently accounts for the majority of the achievement variance. Brinkley (1967) found significant race differences on subscales of the Metropolitan Achievement Tests for pupils drawn from economically depressed neighborhoods of Nashville. . On the other hand, Rea (1967) studying pupils in southern Illinois with the Iowa Test of Basic Skills concluded that race membership did not contribute significantly to predictions of achievement although economic group membership did.

Harris (1968) employed the SRA Test of Educational Ability and the SRA Achievement Series to examine the relationship between ability and achievement among North Carolina Black and White elementary school children. With ability held constant the White students generally did better on the tests. At lower levels of ability the achievement of the two groups was about the same with differences in achievement increasing at the higher ability levels. Curry (1962) using the California Test of Mental Maturity and the California Achievement Test, concluded that socioeconomic status has no effect upon scholastic achievement among sixth grade students if the students have high intellectual ability.

Tulkin (1968), studying fifth and sixth grade pupils in Maryland using the Iowa Test of Basic Skills and the Lorge-Thorndike Intelligence Tests, found significant social class differences in achievement and intelligence with verbal intelligence playing a more pronounced role in predicting achievement at the upper socioeconomic levels.

Stodolsky and Lesser (1967) in their review and synthesis of research related to learning patterns in the disadvantaged find that membership in an ethnic group affects primarily the pattern of abilities developed, while social class affects the level of abilities. They suggest that clusters of attributes (cognitive, personality, motivational, etc.) are related to ethnic group membership and in turn, to school achievement.

Kagan (1968) observed that the most dramatic differences between low and middle class preschool children involve language skills. Ryckman (1967) found a general language ability component the most significant in discriminating between the two socioeconomic groups of Negro kindergarten boys. Singh (1968), however, found that the supposed inferiority for low socioeconomic status pupils on verbal tasks was not substantiated.

Even more surprising is the report of Entwisle (1968). Using a word association test and holding I.Q. constant she found White slum children advanced compared to suburban children at first grade but retarded at third grade. Negro slum children are generally behind White slum children, but at first grade, the Negro slum children are on a par with White suburban children.

In addition to language development, researchers interested in characteristics of disadvantaged children related to school achievement have investigated perceptual-motor development, anxiety, attitudes and values, motivation, response habits and cognitive styles.

Thomas (1966) used an object sorting test with White kindergarten children and concluded that the conceptual behavior of the disadvantaged subjects was of a lower quality than that of the advantaged.

Palomares (1968) tested Mexican-American students from thirteen grade levels in rural California and found that they fell progressively behind in perceptual-motor development. Webb (1969) found Anglo-American, Negro, and Latin-American from lower socioeconomic groups below the norm on the Illinois Test of Psycholinguistic Abilities and the Wepman Auditory Discrimination Test.

Schwartz (1969) studied value orientations and achievement among 2,600 ninth and twelfth grade pupils in the Los Angeles school district and found substantial differences in value orientations between Mexican-Americans and Anglo pupils from similar socioeconomic backgrounds. Gill (1962) examined a variety of scores from psychological tests administered to high achieving and low achieving Mexican-Americans and found that the high achievers show more social maturity, less hostility, more intellectual efficiency and conformity to rules. Their mothers tend to be dominating, possessive and attentive. Davidson (1968) did a similar study with Negro boys and found that the high achievers were more stable, self-realizing and cautious in their thinking. They were more successful at tasks requiring verbal information, conceptual abilities and cognition skills. Thomas (1968) found lower class Puerto Rican school children in New York to be less oriented to task completion than middle class groups.

These studies do not form a clear pattern of interacting factors leading to substandard school achievement. A major problem is the absence of a theoretical model of cognitive growth among disadvantaged children which identifies relevant variables and the nature of their interrelationships. The model would implicitly suggest instruments for observing the variables and lead us to cognitive and affective operations currently obscured by out interest in the gross factors of intelligence, socioeconomic status, and race.

Certainly an adequate model must assume that cognitive growth in disadvantaged children goes on within the subculture of poverty which describes unique perceptions, discriminations, and behavior patterns for its participants. Kagan (1968) provides a glimpse of some of the variables that might be included in such a broadly conceived model. As a mental schemata developes providing the child with mental structures that help him translate experience and discriminate out its distinctive features, factors impinge on the lower class child which mitigate against the development of meanings learned by middle class children. While middle class children learn to value mastery of certain verbal and intellectual skills, the lower class child learns values which do not endow reading, arithmetic, and spelling with nearly as much meaning as such skills acquire for the middle class child.

Cohen (1968) proposes that the mode of selecting and organizing perceptions demanded by the school and society is essentially "analytic." The "analytic" conceptual style is characterized by a variety of cognitive, linguistic, and perceptual behaviors including stimulus centered approaches to problems, attention to parts as opposed to global characteristics, use of many verbal labels, and a reflective rather than impulsive response style. Cohen feels that conceptual styles come about as a direct result of the socialization process and that such conceptual styles may be more critical determinants of pupils' ability to relate to school requirements than are other factors usually associated with class and race discrimination.

Soloman (1969) corroborates many of these observations and points to the need for a broad theory capable of encompassing and integrating the wide range of elements entering into the cognitive operations of disadvantaged individuals.

The point to be emphasized is that measures of achievement do not function as uncontaminated dependent variables in studies of learning among the disadvantaged. More importantly, studies of cognitive variables and achievement are likely to be of limited value if designed mainly with a correlation matrix as the final goal. Such studies are likely to be more fruitful if conceptualized in terms of a dynamic model elucidating habitual responses of the individual to his environment. The model will undoubtedly center on a series of information processing operations mediated by a broad range of cognitive perceptual, and affective variables. As such a model evolves, conventional measures of achievement are likely to give way to tests specifically designed to elicit competencies in coping with problems posed by the individuals' social-cultural environment.

Achievement Measure

Annotated Bibliography

Binkley, M. E. First grade entrance variables related to achievement and personality, a study of cluturally deprived fourth graders. Dissertation Abstracts, 1967, 28, No. 6-A, 2065

Six hundred and seventy-two Black and 438 White 4th grade children from economically depressed neighborhoods in Nashville, Tennessee were administered the Metropolitan Achievement Tests. Significant race differences were found on all of the achievement measurements.

Brunson, F. W. Comparative ratings of intelligence and of achievement of children from low- and middle-socioeconomic areas. Dissertation Abstracts, 1969, 29, No. 12-A, 4318-4319.

This study investigates changes in the measured IQ and in the scholastic achievement of a group of culturally disadvantaged youth as compared to the changes of a corresponding group who attended school in a middle-socioeconomic class area of Omaha, Nebraska. One hundred and fifty seventh grade children were randomly chosen from a school in each of the two socioeconomic areas. Data were collected on each of the two groups as follows: first grade, Metropolitan Readiness Test; second grade, California Achievement Tests; third grade, Kuhlmann-Anderson Intelligence Tests; and the Iowa Test of Basic Skills; and in the sixth grade the Kuhlmann-Anderson Intelligence Tests and the Iowa Test of Basic Skills. The Wechsler Intelligence Scale for Children was also administered.

The tabulations revealed a significant difference between the means of the groups for each variable except the WISC Picture Arrangement.

The magnitudes of changes in the scholastic achievement tests administered to the children in the disadvantaged area were significantly smaller than the changes in achievement of children from the middle-socioeconomic area at all levels sampled.

The intelligence and achievement test scores of the middle socioeconomic group increased. For the disadvantaged group the intelligence test scores remained the same and the achievement test scores, which started in the average range, fell behind national norms by the end of elementary school.

Cohen, R. The relationship between socio-conceptual styles and orientation to school requirements. Sociology of Education, 1968, 41(2), 201.

This study examines cognitive aspects of educational disadvantage. The sample consisted of 66 16 and 17 year olds from various social classes. The tests given included the Sigel Test of Conceptual Style, a paper and pencil adaptation of the Witkin Graphic Figure Embedded Test, a 72 item attitude set, including various instruments designed by the researchers.

The results suggest that conceptual styles are effective predictors of academic success when common demographic variables, native abilities, and a general information repertoires are held constant.

Crosswait, A. B., Jr. A study of selected cognitive and affective variables functioning in two-sub-groups of four economic class fifth and sixth grade pupils in a non-metropolitan area. Dissertation Abstracts, 1967, 27, No. 90A, 2721-2722.

Crosswait examined the relationships among reading, arithmetic, composite achievement, and intelligence for fifth and sixth grade Black and White pupils of lower socioeconomic groups. The students were further subdivided into self-supporting sufficient families, self-supporting depressed families, and public welfare families. Significant differences were found for language IQ and total IQ between children from economically sufficient and economically depressed families. There were no significant differences in the achievement measures when total intelligence was held constant.

Curry, R. L. The effect of socioeconomic status and the scholastic achievement of sixth grade children Part I. British Journal of Educational Psychology, 1962, 32, No. 1, 46-49.

This study examines the relationship between socioeconomic status and achievement among 360 sixth grade pupils from the southwestern section of the United States using the California Test for Mental Maturity and the California Achievement Test. The findings suggest that socioeconomic status has no effect upon scholastic achievement among sixth grade students if the students have high intellectual ability. Within the middle intellectual ability group, socioeconomic factors have an effect on language achievement. At the lower intellectual abilities socioeconomic factors have an effect on achievement in reading, language, and total achievement.

Davidson, H. H., & Greenberg, J. W. Traits of school achievers from a deprived background. Research in Education, 1968, 3, No. 3.

A study was conducted to determine the cognitive, affective, motivational, and physical characteristics of high achieving students from a deprived background. The tests were performed on eighty high and eighty low achievers, equally divided by sex. All were in the fifth grade in school, and were from urban Negro families of low socioeconomic status in New York City. The individual psychological assessments included the Weschler Intelligence Scale for Children, Rorschach, Bender Motor Gestalt Test, Uses for Objects and Object Sorting Tests designed by the researchers. Story telling tasks and a linguistic analysis of oral language samples were also included.

Factor analyses revealed that the high achievers were more stable, self-realizing, and cautious in their thinking. Also, they were more successful than the low achievers at those tasks requiring verbal information, conceptual abilities, and cognitive skills. They did not surpass the low achievers in linguistic complexity, creativity, and curiosity. Organizational skills, formal language, and emotional anxiety were some of the problem areas common to both groups.

Entwisle, D. R. Subcultural differences in children's language development. International Journal of Psychology, 1968, 3(1), 13-22.

Subjects were rural and urban 1st, 3rd, and 4th grade children. A word association test was used to determine verbal ability. The results indicate a negligible difference in the suburban children from the upper and blue collar levels; rural Negro children develop slower than suburban, White slum children were advanced compared to suburban children at the first grade level but were retarded at the third grade level; Negro slum children were behind White slum children but first grade Negro slum children were on a par with White suburban children.

The investigator feels that the degree of urbanization seems to be generally correlated with the rate of development and that television exposure may account for the verbal facility of the six year old slum children.

Fisher, R. L. Thinking style and socioeconomic status. Perceptual and Motor Skills, 1968, 26, No. 3 pt. 1, 825-826.

The purpose of this report is to measure reflectiveness in some of the groups Kagan speculates to be deficient in the reflective quality as compared with measures from a "normal" sample.

Scores on the Conceptual Styles Test were obtained for the following five groups of children in the public elementary schools in Syracuse, New York: (1) 28 fifth grade Negro boys, (2) 22 fifth grade Negro girls - both from a typical Negro ghetto school, (3) 23 fourth and fifth grade lower class White boys whose behavior was so impulsive they could not be contained in a normal classroom, (4) 45 fifth grade "normal" White boys and (5) 45 fifth grade "normal" White girls - both middle class samples similar to the normative sample.

Results indicate that the Conceptual Styles Test does not discriminate any of the groups. Mean scores for the reflective mode, compared with Kagan's norms, were essentially the same for all five samples. Reflectiveness as assessed by the Conceptual Style Test was not related to cultural deprivation or to impulsive behavior.

Gill, L. J., & Spilka, B. Some non-intellectual correlates of academic achievement among Mexican-Smaerican secondary school students. Journal of Educational Psychology, 1962, 53(3), 144-149.

Sixty high school students with no significant difference between sex, class, groups, age or IQ were divided into two groups of thirty each on the basis of achievement. The following instruments were used: Otis (Gamma), Parental Attitude Survey, California Psychological Inventory, Siegel Manifest Hostility Scale, and Jewell Anxiety Adaptation Scale. The results indicate partial support for the belief that achieving students would be from homes in which mothers tend to be dominating, possessive, and attentive. The achievers showed less hostility, more social maturity, intellectual efficiency, and conformity to rules.

Glaser, R., & Cox, R. C. Criterion-referenced testing for the measurement of educational outcomes. In R. A. Weisgerber (Ed.) Instructional Process and Media Innovations. Chicago: Rand McNally & Co., 1968.

Distinctions between norm-referenced measures and criterion-referenced measures are made.

Items most suitable for measuring individual differences in achievement are those which differentiate among individuals all exposed to the same treatment variable, while items most suitable for distinguishing between groups are those which are most likely to indicate that a given amount or kind of some instructional treatment was effective. Measures which assess pupil achievement in terms of a criterion standard thus provide information as to the degree of competence attained by a particular pupil which is independent of reference to the performance of others.

Halasa, O. A developmental study of the attainment of number conservation among economically and culturally disadvantaged children. Dissertation Abstracts, 1967, 28, No. 6-B, 2606-2607.

The purposes of this study are: (1) To examine the developmental attainment of number conservation among economically and culturally disadvantaged children; (2) to determine whether the attainment of number conservation in this population is affected by chronological age, learning level, concept level, and task difficulty level; (3) to examine and evaluate Piaget's methodology in his study of number conservation.

One hundred and sixty-nine children were randomly selected from five inner city schools and eleven headstart centers of the Akron Public School System. The ages of the children ranged from 4½ to 8½ years. The Illinois Test of Psycholinguistic Abilities Visual Motor Association Subtest was used to determine concept level classification.

The findings of this study lend general support and confirmation to Piaget's overall theoritical formulations regarding number conservation. Concept level showed no clear cut association with number conservation except at age 6½ to 7½.

Hanson, E., & Robinson, H. Reading readiness and achievement of primary grade children of different socioeconomic strata. Reading Teacher, 1967, 21(1), 52-56.

This study made use of the Goodenough Draw-A-Man Test, Metropolitan Readiness Test, and the Metropolitan Achievement Tests to investigate the effects of socioeconomic status on reading achievement. Data were collected on 259 subjects classified into three groups: disadvantaged, average, and advantaged. The conclusions suggest that the disadvantaged children enter primary grades less ready to learn to read and the difference tends to increase at each grade level.

Harris, G. R. A study of the academic achievement of selected Negro and White fifth grade pupils when educational ability is held constant. Dissertation Abstracts, 1968, 28, No. 11-A, 4375-4376.

This investigation employed the SRA Test of Educational Ability and SRA Achievement Series to examine the relationship between ability and achievement among 1161 North Carolina Black and White elementary school children. With ability held constant the White students generally did better on the tests. At lower levels of ability the achievement of the two groups was about the same with differences in achievement increasing at the higher ability levels.

Kagan, J. On cultural deprivation. In D. C. Glass (Ed.), *Environmental Influences: Proceedings of a conference under the auspices of Russell Sage Foundation and the Rockefeller University*. New York: Rockefeller University Press, 1968.

Kagan points out that anchoring our concepts of achievement to middle class performance unduly emphasizes purely verbal modes of decoding experience and blinds us to other aspects of performance. In cognitive growth, each succeeding set of experiences change distinctive features and prepare the child to decode and attend to an event that he was unable to assimilate at an earlier time. Kagan relates the role of habituation, reward and punishment and language

"The most dramatic difference between lower-middle-class and middle-class children of preschool or school age involve language skills. Documentation for this conclusion is everywhere." Kagan argues that the language deficit is a consequence not so much of a lower volume of parent-child vocalization within the lower class as a deprivation of "distinctive vocalization" i.e. speech uttered directly to the infant without the presence of other distracting stimuli.

Kennedy, W. A., VandeRiet, V., & White, J. C. A normative sample of intelligence and achievement of Negro elementary school children in the southeastern United States. *Monographs of the Society for Research in Child Development*, 1963, *28*(6), 112.

The purpose of this research is to provide individual psychologists and educators who perform diagnostic evaluations on Negro school children with normative data for the parent population. Particular concern is with Binet test results.

A stratified sample of 1800 elementary school age children representing five southeastern states - Florida, Georgia, Alabama, Tennessee, and South Carolina - were given the 1960 Revision, Form L-M of the Stanford Binet Intelligence Test, the 1957 Revision of the California Achievement Test, and a demographic data sheet was obtained for each child.

The most important data obtained were the means and standard deviations of the Binet IQ, the mental ages, and the California grade placements. Negro elementary school children had a mean IQ of 80.7 and a standard deviation of 12.4 as compared with Terman and Merrill's data of a mean IQ of 101.8 and a standard deviation of 16.4. The Stanford-Binet MA's and CAT subtest correlations are: reading .68, arithmetic .64, language .70, and total battery .69. Stanford-Binet IQ demographic variables: socioeconomic status .27 and community size .17.

Michael, J. J. Structure of intellect theory and the validity of achievement examinations. Education and Psychological Measurement, 1968 28, No. 4, 1141-1149.

The purposes of this study are (1) to survey the present status of achievement tests, (2) to discuss implications of this status, and (3) to set forth proposals for the role of structure of intellect theory in achievement testing. The author feels that current standardized tests top only a handful of SI factors. He also feels that achievement tests need to reflect educational objectives.

Mitchell, C. Predictive validity of the Metropolitian Readiness Tests and the Murphy Durrell coding readiness analysis for white and for Negro pupils. Educational and Psychological Measruement, 1967, 27, No. 4(pt. 2), 1047-1054.

This study examines the predictive validity of the Murphy-Durrell Reading Readiness Analysis and the Metropolitan Readiness Test for four ethnic groups: blacks, whites, Mexicans, and Orientals. From the data collected on over 7000 pupils it would appear that the general level of predictive validity for these two tests is similar for the four ethnic groups studied.

Morper, J. An investigation of the relationships of certain predictive variables and academic achievement of Spanish-American and Anglo pupils in junior high school. Dissertation Abstracts, 1967, 27, No. 12-A, 4051.

A random sample of 50 Spanish-America and 50 Anglo, were administered the Wechsler Intelligence Test for Children, the School and College Ability Test, and the Lorge-Thorndike Verbal and Non-Verbal Tests. Academic achievement was measured by the composite Grade Point Average obtained at the end of the academic year in English, science, & mathematics and Metropolitan Achievement Test, Intermediate Battery.

The WISC & The Lorge-Thorndike Non-Verbal Test failed to significantly correlate with The Metropolitan Achievement Test with the Spanish-American group. For both ethnic-groups all variables reached the desired level of confidence with the Grade Point Achievement criterion. The greatest differences between the Spanish-American and Anglo ethnic groups were observed when reading ability and comprehension were most involved in the obtaining of a measurement.

Osburn, H. G. Item sampling for achievement testing. Houston: Psychology Department, University of Houston, 1967, mimeographed paper.

The investigator asserts that the most important requirement for the operational definition of a test is the specification of the universe of content. Test items should represent a random sample from such a universe. Conventional item analysis procedures destroy the random sampling feature of the final test. The author argues that such proceudres are not appropriate for achievement testing and suggests using computer technology and a set of algorithms to gnerate test items.

Palomares, W. H., & Cummins, E. J. Assessment of rural Mexican-American pupils, preschool and grades one through twelve. Research in Education 1968, 3, No. 12.

171 Mexican-American students from 13 grade levels within the Wasco, California Public Schools were tested as part of an evaluation of strengths and weaknesses of rural Mexican-American students in California Tests given in the areas of perceptual-motor, social emotional and intellectual academic development included the Frostig Developmental Test of Visual Perception, Bender Visual Motor Gestalt Test, California Test of Personality, Vineland Social Maturity Scale, California Test of Mental Maturity (short form) Goodenough-Harris Drawing Test, Wechsler Intelligence Scale for Children; Wechsler Adult Intelligence Scale, California Achievement Test and Multiple Aptitude Tests. Testing was conducted both by local school personnel and a team of research psychologists.

Analysis of test results revealed that Mexican-American students fell progressively behind in perceptual motor development, a deficit attributed to both home and school environments. Low self-concept scores and above normal social maturity scores may have reflected the demands of two cultures on the Mexican-American student. Academic achievement progressively declined, possibly as a result of the de-emphasizing of individual instruction and the abstraction demands made on Mexican-American students by materials geared to middle-class norms.

Rea, R. E. An analysis of academic achievement of economic groups and race as categories in grades five and six when need achievement, intelligence and sex are held constant. Dissertation Abstracts, 1967, 27, No. 9-A, 2747-2748.

This study employed the California Mental Maturity Test and the Iowa Test of Basic Skills to investigate the effects of economic groups and race on achievement with 400 fifth and sixth grade pupils in Southern Illinois. The findings indicate that economic group membership did contribute significant predictive efficiency when predictions of achievement are based on sex, race, intelligence, and need achievement. Race membership did not contribute significantly when added to the other variables.

Reid, W. R., & Schoer, L. A. Reading achievement, social class, and subtest patterns on the WISC. *Journal of Educational Research*, 1966, *59*, No. 10, 469-472.

The WISC subtest patterns of 87 4th grade males were analyzed to determine the relationship between the patterns of reading achievement and social class. All social-class effects and interactions involving social class were non-significant. Scores on three Verbal Scale subtest (Arithmetic, Similarities, & Digit Span) & one Performance Scale subtest (Picture Completion) were found to be significantly related to reading achievement.

Rice, V. An appraisal of the predictive value of patterns of subtest scores in achievement test batteries. *Dissertation Abstracts*, 1967, *28*, No. 4-A, 1267.

This study examined patterns of achievement as revealed by the Iowa Test of Basic Skills, Lorge-Thorndike Intelligence Test, Differential Aptitude Tests, and the Iowa Test of Educational Development. The conclusions indicate that students at different levels of ability use different sets of skills for mastering information.

Rosenfield, M. Negro-white differences in intellectual growth. *Research in Education*, 1969, *4*, No. 4.

This is a longitudinal investigation of the intellectual growth of groups of Negro and white students. Analyses of variance were conducted for grades five, seven, nine, and eleven on student scores from Sequential Tests of Educational Progress, School and College Ability Tests, and a measure of socio-economic status taken from the Background and Experience Questionnaire all of which were administered as part of the Educational Testing service Study of Academic Growth and Prediction. Some 316 Negro and 501 white students constituted the sample. The data indicated that: (1) Test scores of white subjects were significantly higher than Negroes at grade five as all tests of SCAT, STEP, and a measure of socio-economic status; (2) when analyses of variance were used to equate on racial differences in SCAT and STEP whites were found not only to start out higher, but to grow at a faster rate than Negroes on most battery tests; (3) both Negro and white students continue to grow and gain on all tests of SCAT and STEP; and (4) Negro academic students showed accelerated growth rates on reading and listening relative to white nonacademic students in one town, but not in the other.

Ryckman, D. B. A comparison of information processing abilities of middle and lower class Negro kindergarten boys. *Exceptional Children*, 1967, *33*, No. 8, 545-552.

The purpose of this study is to examine the relationship between social class and cognitive abilities of Negro kindergarten boys.

Fifty middle class and fifty lower class Negro kindergarten boys ranging in ages between four years, eleven months to five years, eleven months, were administered a battery of eight instruments designed to assess specific information processing abilities.

An analysis of nineteen variables produced five components, with a general language ability component the most significant and accounting for almost twice as much variance as the second largest component. When class groups were compared, this component discriminated most significantly between the groups. All eighteen cognitive varibles discriminated between the socioeconomic groups in favor of the middle class boys ($p < .01$).

Schwartz, A. J. Comparative values and achievement of Mexican-American and Anglo pupils. Research in Education, 1969, 4, No. 9.

Value orientations and academic achievement of Mexican-American and Anglo public school youth were studied with regard to differences between Mexican-American and Anglo values, value differences within the Mexican-American pupil subpopulations, and the relationship between value orientations and academic achievement of Mexican-American pupils. Data were obtained from a self-administered questionnaire and from official records of scholastic achievement of 2,600 ninth and twelfth grade pupils enrolled in the Los Angeles Metropolitan School District. The results indicated that: (1) there were substantial differences in some special value orientations between Mexican-Americans and Anglo pupils from similar socioeconomic backgrounds; (2) similarities to Anglo value orientations and academic achievement increased with a rise in socio economic status of Mexican Americans and from the ninth to twelfth grade levels; (3) value orientations of Mexican-American pupils in integrated schools were more similar to those of Anglos than Mexican-American pupils in other schools; and (4) there were fewer differences in value orientations between Anglo boys and girls than there were between Mexican-American boys and girls.

Scott, R. Ceiling level as a factor in assessing disadvantaged children's abilities. Psychology in the Schools, 1969, 6, No. 3, 279-282.

The purpose of this report is to present the findings of an experiment aimed at determining whether a Seriation Test would more accurately identify disadvantaged children if the ceiling were extended from four to eight consecutive item failures. The major hypothesis is that the disadvantaged child who has failed four or more consecutive items and then found the "set" to problem solving has coping mechanisms and capabilities which augur well for learning.

An experimental Seriation Test developed by Ralph Scott and colleagues, was administered to all the second grade children of four Waterloo, Iowa schools which were representative of social-class populations residing within the city. Two separate Seriation Test scores were obtained for each *S*. One score was computed using a restricted ceiling of four consecutive item failures; the other score consisted of an extended ceiling of eight consecutive item failures. The two sets of Seriation Test scores were correlated with second grade reading achievement as measured by the California Achievement Test.

The results reveal that extending the ceiling to eight consecutive item failures raised the Seriation Test scores of more Negro than White *S*s. Increasing the ceiling raised the mean Negro score by 13.01 points while the mean White increased was 6.4 level The ceiling effect did not alter the predictive validity of the instrument with White *S*s but did substantially alter the predictive coefficients with Negro *S*s. Increasing the ceiling appreciably increased the predictive validity and reduced the dispersion of female Negro *S*s; at the same time some reduction in the predictive coefficients with male Negro *S*s is noted.

Sigel, I. E., & Perey, A. Psycholinguistic diversity among "culturally deprived" children. *American Journal of Orthopsychiatry*, 1968, *58*, No. 1, 122-126.

This study suggests that the term "culturally deprived" may be to broad to be useful.

Twenty-five Negro preschool children ranging in age from three years to six years were tested. This sample represented diverse family structure and educational background of the parents but were from the same neighborhood in an inner city section of Detroit.

Test results reveal a wide range of abilities and competence among the children. Although the distribution of scores of the sample children is skewed toward the lower end of the distribution, overlapping of scores with the norm for the general population does exist. Considerable with-in child variability, reflecting a wide array of psycholinguistic competencies, was also revealed. Recording of test-related behavior demonstrated further diversity among these children.

Singh, S. P. A comparison between priviledged Negroes, underprivilaged Negroes, privilaged whites and underpriviledged white children on a test of creativity. Dissertation Abstracts, 1968, 28, No. 7-A, 2569-2570.

This study investigated the difference and similarities among four groups of children at two grade levels (grades one and six - priviledge whites, underpriviledged whites, priviledged and underpriviledged Negroes) on components of creative abilities. Creativity was measured by the Meffessel Individual Test of Creativity. The 200 subjects were randomly chosen and matched groups were selected from the Tampa School System.

There were significant differences between priviledged and underpriviledged children in favor of underpriviledged on redefinition (verbal), redefinition (performance), fluency (verbal), sensitivity to problems (performance) and elaboration (verbal). There were also significant differences in favor of priviledged children on flexibility (performance), originality (verbal) and originality (performance). There were no significant differences found on fluency (performance), sensitivity to problems (performance) and elaboration (performance). With the exception of redefinition (verbal) there was difference in measures of the components of creativity between first and sixth graders in favor of the sixth grade children. No significant differences were found between Negro and White children on measures of redefinition (verbal), fluency (verbal), flexibility (verbal), originality (verbal) and elaboration (performance).

Overall findings showed that creativity as described in the study increases with age, but does not reflect age. With an increase in socioeconomic status, abilities such as flexibility and originality excel at the cost of redefinition, fluency, sensitivity to problem and elaboration. The supposed inferiority for low socio economic status on verbal tasks was not substantiated.

Thomas, A. Retardation in intellectual development of lower-class Pureto Rican children in New York City. Research in Education, 1968, 3, No. 8.

This study attempted to determine the environmental patterns which are detrimental or beneficial to the optimal learning and intellectual development of lower class Puerto Rican Children. A sample population consisted of 95 children whose behavior had been followed since early infancy and their older school-age siblings, a group of 136 middle class children was chosen for comparative analysis of certain items. All children between the ages of 6 and 14 were tested with the WISC, and those from 15 to 17 were tested with WAIS. All tests were given by three psychologists, two of whom were Puerto Rican. These children were also given the Stanford Binet Form L at various times during the longitudinal study , as well as the Metropolitan Reading Achievement Test (Comprehension). An analysis of the findings showed that (1) I.Q. test results varied according to the tester and were unconnected with any language barrier, (2) these scores did not decrease with chronological age, (3) the overall academic ahcievement of the sample was below normal (4) the experimental group was less oriented toward task completion than the middle class group, and (5) the language development of the sample group was not retarded by bilingualism.

Thomas, E. C. The conceptualization process in advantaged and disadvantaged kindergarten children. *Dissertation Abstracts*, 1966, *27*, No. 3-A, 682-683.

An object sorting test was used to ascertain the extent to which the process necessary for classificatory behavior is operative in disadvantaged groups. Sixty white kindergarten children were equally divided as to socio·economic group and sex. The conceptual behavior of the disadvantaged subjects was of a lower quality than that of the advantaged.

Tulkin, S. R. Race, class, family, and school achievement. *Journal of Personality and Social Psychology*, 1968, *9*, No. 1, 31-37.

The Iowa Test of Basic Skills and the Lorge-Thorndike Intelligence Tests were used to investigate the relationships among race, class, and school achievement in a sample of 389 fifth and sixth grade pupils in Maryland. Social class differences were significant for the measures of intelligence and achievement and for such background factors as number of siblings, crowdedness, family participation, and cultural participation. Verbal intelligence accounts for a much larger portion of the variance associated with total achievement in the upper socio-economic group.

Tulkin, S. R., Newbrough, J. R. Social class, race, and sex differences on the Raven (1956) standard progressive matrices. *Journal of Consulting and Clinical Psychology*, 1968, *32*, No. 4, 400-406.

The Raven Standard Progressive Matrices Test, the Lorge-Thorndike, and the Iowa Test of Basic Skills were used to investigate the effects of race, social class, and sex on school achievement among 356 fifth and sixth grade Black and White pupils. There were significant main effects for social class and race but no significant interaction effects.

Wakefield, M. W. A comparative study of language patterns in low socio-economic first graders. Dissertation Abstracts, 1968, 29, No. 4-A, 1056.

Oral responses to stimulus pictures were analyzed in search for different syntactical patterns among Negro, Spanish-surname, and Anglo first grade children in Phoneix, Arizona. The language samples were recorded on magnetic tape and then transcribed to type. The typescripts were analyzed for frequency of 10 basic English sentence patterns. Analysis of variance revealed no significant difference in the oral language patterns in the three low socioeconomic groups studied.

Webb, P. K. A comparison of the psycholinguistic abilities of Anglo-American, Negro, and Latin American lower-class preschool children. Dissertation Abstracts, 1969, 29, No. 10-A, 3351-3352.

Sixty children, twenth Anglo-American, twenty Negro, and twenty Latin-American, all from lower socio-economic groups were administered the Illinois Test of Psycholinguistic Abilities (ITPA) and the Wepman Auditory Discrimination Test. All children were between five and six years of age. All groups scored below the normative sample. The Negro & Latin-American were significantly below the Anglo-American children in total language facility. On subscores of the ITPA there were no significant differences between the Anglo-American and Negro children and both groups significantly out performed the Latin-American children. These findings held also for the auditory discrimination measures.

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